

# **Aspiration and Reality in the Teaching and Learning of Science in Tanzania**

**F. Ruth Wedgwood**

**Doctor of Philosophy**

**The University of Edinburgh**

**2007**



## **Declaration**

This thesis has been composed by myself from the results of my own work, except where otherwise acknowledged. It has not been submitted in any previous application for a degree.

Frances Ruth Wedgwood



## **Abstract**

Throughout the twentieth century, policy makers attempted to make education in Tanzania more locally relevant and indigenised, but most Tanzanians aspired to an education that fitted with their image of modernity, based on Western academic traditions. This image generally included laboratory-based, pure science taught in English. It also came to involve the use of Western pedagogies. Since the late 1990s, a teaching style known as 'participatory teaching methodology' has been disseminated through teacher training programmes. It was based on donor-led training methodologies and European theories of learning. However, efforts to make the teaching and learning of science more learner-centred have met with limited success.

Cultural differences in attitudes to knowledge and learning could explain some of the barriers to adoption and successful implementation of Western pedagogies. This study therefore examined Tanzanian science educators' views about the type of knowledge that should be promoted in schools and the models of learning that guide their practice. Data relating to practitioners were generated through lesson observations and follow up interviews with teachers, trainees and tutors at six secondary schools and one teacher training college. These data were supported by ethnographic observations, interviews with students, trainees' written descriptions of their best science teachers, analysis of curricular materials and interviews with policy makers.

The findings indicate that many teachers based their science teaching on a model of science as a set body of codified knowledge that needs to be learned verbatim. This body of knowledge is replicated and conserved through hand-copied student notes. Teachers interpreted the ability to reproduce the resulting "sacred text" orally as evidence of successful learning. Observation, analysis and knowledge manipulation were not highly valued. Many aspects of the observed folk pedagogy were similar to those found in highly oral societies. Although teachers agreed that the student is an important source of knowledge in the classroom, and attempted to access student knowledge through oral questioning and group work, they rarely acknowledged or

attempted to access student experience, focusing only on their text-based knowledge. Participatory teaching methods were used to enable the students to participate in the replication and transmission of the sacred text. Whilst the teacher's authority as a knowledge source was foregone, the authority of the text was upheld.

Aspirations to achieve modernity have led to the rapid expansion of the education system, high resource demands for science teaching in terms of equipment and the use of English as the medium of instruction. The teachers shared these high aspirations and yet were faced with realities that made them unattainable. Teachers lacked robust content knowledge, schools lacked books and apparatus and students lacked access to understanding due to the language barrier. This appeared to have contributed to the development of a survivalist pedagogy that had become culturally engrained and resistant to change. The pursuit of modernity, it is suggested, has inhibited the achievement of scientific literacy through a perpetuation of the traditional oral pedagogic culture.

## Acknowledgements

This study was inspired by conversations and shared experiences with friends and colleagues in Kondo. I would particularly like to thank Agnes Muraba, Mr Sulu, Mama Mosha and Mama Mtawa for their insights into science teaching in Tanzania and their advice and encouragement. I would also like to thank the staff of the teacher training college and schools involved in the research for being so generous with their time and their insights into the teaching process, but also for their friendship, which made the research a rich and enjoyable experience. I am very grateful to the Mwamatandalas for their hospitality and support.

I would like to thank my supervisors, Kenneth King, Dai Hounsell and Gari Donn for their advice and guidance and for encouraging me to clarify my ideas.

I am very grateful to the staff at the Faculty of Education, University of Dar es Salaam, who helped me with the research process. I would like to acknowledge Tanzania Commission for Science and Technology, and the Ministry of Education and Culture for granting me access to carry out research within the education system in Tanzania. I would also like to acknowledge the financial support of the Economic and Social Research Council that made this work possible.



# Contents

<b>Abstract.....</b>	<b>i</b>
<b>Acknowledgements .....</b>	<b>iii</b>
<b>Contents .....</b>	<b>v</b>
<b>List of Tables.....</b>	<b>vii</b>
<b>List of Figures .....</b>	<b>vii</b>
<b>List of Abbreviations .....</b>	<b>ix</b>
 <b>Introduction .....</b>	 <b>1</b>
Questions from the field.....	1
Aspiration and reality in Tanzanian education .....	5
Chapter outline.....	8
 <b>1. Pedagogy, Culture and Science.....</b>	 <b>15</b>
1.1. What is Good Pedagogy? Western models.....	16
1.2. International Perspectives on Pedagogy .....	23
1.3. Pedagogy as Culture .....	26
1.4. Areas of Cultural Conflict between Western Pedagogy and African Cultures	
29	
1.4.1. Collectivism Versus Individualism .....	30
1.4.2. Authority of the teacher .....	34
1.4.3. School Science and the African Worldview .....	35
1.4.4. Authority of Knowledge .....	37
1.4.5. Orality and Literacy .....	39
1.5. Tacit Knowledge in Science and its Distribution.....	43
1.6. Conclusions.....	47
 <b>2. Education for Adaptation or for Modernity? An historical overview of the</b>	
<b>pedagogical influences in Tanzania's education system.....</b>	<b>51</b>
2.1. Pre-Colonial education .....	52
2.2. Education under European rule.....	54
2.3. After Independence .....	60
2.4. Participatory teaching methodology.....	75
2.5. Choice of medium of instruction.....	79
2.6. Societal expectations and pedagogy.....	83
2.7. Conclusion .....	85
 <b>3. Research Design and Methodological Issues.....</b>	 <b>89</b>
3.1. The methodological challenge of researching education in Africa.....	90
3.2. Ethical considerations.....	93
3.3. The evolution of the research questions .....	96
3.4. The research site and range of informants.....	99
3.5. Research methods.....	102
3.6. Data analysis .....	109

3.7.	Generalisability and validity.....	112
3.8.	Objectivity .....	116
3.9.	Language considerations .....	117
3.10.	Concluding comments.....	119
<b>4.</b>	<b>Sources of Knowledge in the Science Classroom.....</b>	<b>121</b>
4.1.	Teachers' own education.....	122
4.2.	Teacher training at diploma level .....	127
4.2.1.	The official curriculum.....	127
4.2.2.	The curriculum in practice.....	132
4.2.3.	Pedagogic knowledge and content knowledge .....	139
4.3.	Trainees' images of teaching.....	142
4.3.1.	"My best science teacher" .....	143
4.3.2.	The attributes of a good teacher.....	145
4.3.3.	Metaphors for teachers, learners and teaching.....	146
4.4.	Teachers' experiential knowledge .....	148
4.5.	Books .....	150
4.5.1.	Published texts .....	150
4.5.2.	The hidden text book.....	153
4.6.	Students as a knowledge source .....	155
4.7.	The separation of theory and practice .....	162
<b>5.</b>	<b>Classroom Culture and Pedagogy.....</b>	<b>165</b>
5.1.	The organisation of knowledge .....	167
5.1.1.	The importance of definitions.....	167
5.1.2.	Categorisation of knowledge into discrete formal categories.....	174
5.2.	Presentation of knowledge .....	176
5.2.1.	The lesson plan .....	176
5.2.2.	Teacher led 'discussions' .....	178
5.2.3.	Group discussions .....	183
5.2.4.	Other methods.....	186
5.2.5.	Peer teaching.....	187
5.2.6.	Use of Kiswahili in schools .....	188
5.2.7.	Taking notes.....	192
5.2.8.	Practical work .....	194
5.3.	Assessment .....	198
5.3.1.	Written work .....	198
5.3.2.	Oral assessment.....	199
5.3.3.	A binary model of understanding.....	199
5.3.4.	Tests and examinations .....	201
5.4.	Authority of the text.....	204
<b>6.</b>	<b>The Race for Modernity: Analysis of the Influences on Pedagogical Culture.....</b>	<b>207</b>
6.1.	Is the current pedagogic culture just a stage in development? .....	208
6.1.1.	The image of modernity .....	210
6.2.	Pedagogical outcomes of the race for modernity .....	215
6.2.1.	Rapid Expansion of the Education System.....	219
6.2.2.	Scarcity of knowledge sources .....	223

6.2.3. Learning 'proper' science .....	225
6.2.4. Learning through English .....	229
6.3. Potential for change .....	232
6.3.1. Escaping the sacred text.....	232
6.3.2. Introducing more practice based, experiential learning.....	234
6.4. Conclusion .....	235
<b>7. Conclusions.....</b>	<b>237</b>
7.1. Folk pedagogies: rooted in tradition but sustained by the pursuit of modernity.....	238
7.2. <i>Njia shirikishi</i> as a modern indigenous pedagogy.....	245
7.3. Culture and pedagogical change .....	249
7.4. Implications for further research.....	253
<b>Bibliography.....</b>	<b>257</b>
Appendix 1: Fieldwork timeline.....	277
Appendix 2: List of Policy Makers Interviewed .....	279
Appendix 3: Example transcripts of lesson observation and follow-up interview, with coding.....	281
Appendix 4: Preliminary Findings as Presented to Teachers/Tutors at Feedback Workshops.....	293
Appendix 5: Assessment form for trainees on teaching practice .....	295
Appendix 6: Common Science Texts in Tanzanian Schools .....	297

## List of Tables

Table 3.1: Sources of data relating to practice: formal interviews and lesson observation .....	102
Table 4.1: Summary of training and experience levels of sampled teachers .....	122
Table 4.2: Subjects and time allocations at Zebaki TTC .....	128
Table 4.3: Most commonly mentioned characteristics in trainees' descriptions of 'My best science teacher'. .....	144
Table 4.4: Most and least important characteristics of a good teacher- as identified by trainees from a list .....	145

## List of Figures

Figure 3.1: Summary of sources of data relating to pedagogical practice.....	100
Figure 4.1: Zebaki TTC trainees' A' level grades (2004).....	124
Figure 6.1: How the image of modernity could lead to the observed pedagogical culture .....	217
Figure 6.2: How pedagogical culture arising from the image of modernity clashes with Western models of participatory methodology. ....	218





## **List of Abbreviations**

AIDS	Acquired Immuno-deficiency Syndrome
DfID	Department for International Development
EFA	Education for All
ELTSP	English Language Teaching Support Project
ERA	Educational Research Abstracts
ERIC	Education Resources Information Centre
ESR	Education for Self-Reliance
GER	Gross Enrolment Ratio
GTZ	German Agency for Technical Co-operation
HIV	Human Immunodeficiency Virus
IMF	International Monetary Fund
KfW	German Development Bank
MDGs	Millennium Development Goals
MoEC	Ministry of Education and Culture
NECTA	National Examinations Council of Tanzania
NER	Net Enrolment Ratio
PEDP	Primary Education Development Programme
SAP	Structural Adjustment Policy
SEDP	Secondary Education Development Programme
SESS	Science Education for Secondary Schools
SIDA/Sida	Swedish International Development Agency
SIE	Stockholm Institute of Education
SMASSE	Strengthening Mathematics and Science at Secondary Education
SSP	School Science Project
TEP	Tutor Education Programme
TEPT	Teachers' Education Project in Tanzania
TIE	Tanzania Institute of Education
TIMSS	Trends in International Mathematics and Science Studies
TSh	Tanzanian Shillings
TTC	Teacher Training College

UDSM	University of Dar es Salaam
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNFPA	United Nations Population Fund
UNICEF	United Nations Children's Fund
UPE	Universal Primary Education
URoT	United Republic of Tanzania
US\$	United States Dollars
VIPP	Visualisation in Participatory Programme
VSO	Voluntary Services Overseas
WEF	World Education Forum
ZPD	Zone of Proximal Development

# Introduction

## **Questions from the field**

This thesis originated from a personal curiosity with the way that Tanzanian science teachers taught. Between 1999 and 2001 I worked as an in-service science teacher trainer on the Science Education in Secondary School (SESS) project. I was based in one school, where I taught part time, and visited other schools in the area to observe lessons, team-teach, demonstration teach and generally support science teachers in their work. The overarching aim of the project was to improve the quality of science education in Tanzania. One of its main strategies to achieve this aim was through in-service teacher training workshops. These workshops focused on introducing more activity based pedagogies, with students learning through discovery using practical work.

The project involved a cascade model of training with a select group of Tanzanian educators trained as facilitators at workshops run by European teacher trainers. These facilitators then ran workshops to train other teachers as trainers and then these trainers were expected to train their fellow teachers in cluster workshops. My role was to assist at each level in order to ensure that the cascade reached down to the classroom. Observing the knowledge transfer at each step of the cascade was somewhat like observing a game of Chinese whispers. The underlying pedagogic meanings of the teaching techniques were lost or altered at each step of the process; so what took place in classrooms often held very little resemblance to the training provided by the international experts.

Tanzanian colleagues generally pointed to the lack of physical resources as the key limitation to pedagogy. The schools I worked with varied greatly in terms of their resource levels. One school had fully equipped laboratories with almost all of the equipment that I would expect to find in a British school, plus crates and crates of unopened boxes of glassware for experiments. Whereas at the school in which I taught, the laboratory was an incomplete shell and the science equipment consisted

of one test tube and an unlabelled reagent bottle with a stopper that had been half eaten by a rat. Classes that I taught or observed varied in size between 60 and 16. Some classes had one textbook per student, others had just one textbook for the teacher. Yet despite these huge variations in resource levels, the pedagogical techniques used by the teachers appeared to be remarkably uniform.

An observation carried out as part of the evaluation of SESS activities highlights the need to go beyond physical resources when looking at the limitations on pedagogy. The evaluators observed a physics lesson taught to a class of two students. Both students had a textbook and the lesson was carried out in an equipped laboratory. The lesson consisted of the teacher lecturing and writing notes from the textbook with no changes to the text (Frommer and Weingardt 2003: 64). The limited impact of resources and training on pedagogy led me to consider cultural influences. Frequent encounters with cultural incomprehension within my work and through participation in other educational practices made me start to question whether there was a fundamental cultural barrier to the adoption of Western pedagogies. Three instances of this 'cultural incomprehension' are described below.

### **Cameo 1: Compass Constructions**

Mr Murrage<sup>1</sup> was teaching his form I class how to construct parallel lines using a pair of compasses. The first half of the lesson was spent with the teacher giving a list of instructions for the construction. It was a complex seven-step process that involved drawing an arbitrary line and four arcs based on four different centres (labelled P, Q, R, S). The teacher then demonstrated each of the steps using a pair of board compasses. After copying out the instructions, the class were asked to do their own constructions. This was the first time that the class had ever used compasses. Circulating the class, I did not find one student who was able to carry out the construction correctly. They were hampered by the fact that there were few compasses and that most of the sets were too loose, so that they tended to slip whilst in use. However, the main barrier to the students completing the work was that they had not developed the skill of using a pair of compasses. Many simply drew

---

<sup>1</sup> Not his real name.

freehand, but rather wobbly arcs with the pencil locked into the compass. In this way they produced imitations of what the teacher had drawn on the board without using their compasses to make an accurate construction.

In the debriefing after the lesson we discussed the problem that students were unable to use the compasses. I suggested that the teacher spent some time getting the class to draw simple, fun constructions such as circles and stars in order to develop their skill at using compasses. He rejected this on the basis that there was not enough time. I asked him what he was going to do about the fact that most students had not managed to do the construction. He said that he would have to repeat the lesson next period.

### **Cameo 2: Bar-side curriculum analysis**

One evening during a workshop for chemistry facilitators, I was sat in a bar with my Tanzanian colleagues. The group included science teachers, inspectors, and teacher trainers. Conversation turned to the 1997 syllabus that would be examined that year for the first time. There was dissatisfaction with the way that some topics appeared more than once. The topic of 'Elements', for example, was covered in form I and form II. 'Why not just teach it once?' my colleagues mused.

During the day we had carried out a number of simple experiments, with different groups working on different experiments at the same time. We talked about these experiments in the evening and the course participants were very enthusiastic about them. But when I asked them if they could do them in class they said that there was not enough time to do all of the experiments as there was too much to cover in the syllabus. They were also concerned about the cost implications of finding enough equipment for the whole class to carry out each experiment. Even though the resources required were relatively cheap and readily available, the costs can mount up if all students are to be provided with equipment. To overcome these problems, I suggested doing the experiments in a circus, with groups of students working on different experiments at the same time, and then all groups moving round, as we had

just done in the workshop. The reaction to my suggestion was laughter. That could not be done in schools! Different groups of students would learn different things!

### **Cameo 3: A Kiswahili lesson**

After I had been working for about six months I approached a friend who was a secondary school Kiswahili teacher, to ask if he would give me some language lessons. I already spoke enough Kiswahili to get by in simple conversations, but I wanted to improve. The discussion concerning when and where to carry out the lessons was in Kiswahili, as were almost all of our conversations, albeit somewhat broken on my side. I was hoping to learn some more advanced grammar and vocabulary that would enable me to be more fluent. When the time came for the lesson, we went to an empty classroom. I sat at a desk and he stood at the board. He then proceeded to take me through the first few pages of the standard I primary school Kiswahili textbook. This textbook had been written for seven year-old primary school children with very little experience of writing or grammar and the first few pages were devoted to learning to pronounce and read vowel sounds (“ba, be, bi, bo, bu” etc.). He had the textbook; I sat at an empty desk. After an hour of repeating simple syllable sounds that he wrote on the board I thanked him for his help and confessed that I was too busy to spare time for any more lessons.

Just as the chemistry educators had reacted with laughter to my suggestion of using a circus of experiments, my initial reaction to occasions such as the Kiswahili lesson or the lesson on compass constructions was one of such disbelief as to provoke suppressed laughter (although not in front of my colleagues). This laughter came from cultural confusion. I did not understand what was going on, what rationale the teachers were working to, what understandings and knowledge were informing their actions and words. We appeared to be working to a different set of assumptions about teaching and learning. These moments of intercultural incomprehension may initially create a sense of the ridiculous, leading to laughter, but they signpost a need for enquiry into the different assumptions underlying the rationales for different approaches to teaching. It was these underlying, perhaps cultural, determinants of

pedagogy that interested me, as the more superficial influences such as teacher training and resource provision appeared to have little impact.

### **Aspiration and reality in Tanzanian education**

There are many questions that a Western observer might ask about the rationale behind much of secondary science education in Tanzania. Firstly, why are they learning this? What possible relevance can much of the curriculum have for the majority of the learners? Do Tanzanian youth really need to know how to carry out a titration or to describe the production of coal gas? The inclusion of titrations in the curriculum might appear strange to the outsider, not only due to the apparent irrelevance, but also due to the stark contrast between the expensive equipment needed to teach it and the limited resources available. In many schools there were no laboratories and students learned about chemicals and apparatus that they would never see or use. It might appear more logical to the outsider for the Tanzanian science syllabi to be adapted to take into account the limited resources that most schools have access to. Another question that might be raised is: why is the official medium of instruction English when the majority of what takes place in schools is carried out in Kiswahili? To a visitor it appears strange that secondary students are expected to study the curriculum in English when only a handful of adult Tanzanians need to use the language on a regular basis. These questions arise as a result of judging what is relevant from the viewpoint of an external observer.

An examination of the local relevance of the science curriculum raises also questions about the universality of Western science. The curriculum focuses on conventional science and makes almost no mention of indigenous knowledge about nature. Tanzanian science, embedded in traditional medicines, brewing, agriculture, iron smelting and other technologies, is given very little attention within secondary science teaching. The imposition of Western science on Tanzanians could be seen as a form of cultural imperialism and it could therefore be argued that science education should take indigenous knowledge into greater account. Poor performance in science examinations by students in Tanzania and other African countries could be seen as



symptomatic of a system that promotes foreign knowledge and devalues indigenous knowledge. The same could also be argued about Western pedagogical models. The apparent failure of projects aimed at improving science teaching could be due to a clash between the Western models being introduced and indigenous models of teaching. This mismatch could be seen as much as a problem with the Western pedagogies as with the indigenous ones. Western teaching methods have been developed within a very different environment to that of Tanzanian schools and may not be as well suited to the Tanzanian environment as locally developed approaches. If indigenous ideas about science and about pedagogy are attributed with the same worth as Western ideas, then indigenous knowledge should be promoted and the import of Western ideas resisted. This line of argument is explored further in chapter one.

At the outset of my PhD, fuelled by post-colonial writings, I developed a relativistic view of science education in Tanzania as a form of cultural imperialism. I fully agreed with the argument given above that the problem of science education in Tanzania lay with the Western forms of science and pedagogy. I saw the science education in Tanzania that I had observed as something imposed by powerful Western states through colonialism and the neo-colonialism of international development agendas. I had thought to uncover 'Tanzanian science' and 'Tanzanian pedagogy' as a defence against and alternative to the hegemony of Western knowledge. But reflection on the history of education in Tanzania and conversations at an early stage of the fieldwork made me reconsider my position.

My own personal journey has much in common with that of Helen Verran. In her book *Science and African Logic* (Verran 2001), she traces her thinking through disconcertment, to relativism to self-critique. Verran, like me, started her journey as a teacher trainer in Africa, and was disconcerted by practices that she observed in mathematics classrooms. She began to make sense of her observations by contrasting Yoruba number and Western number as separate logical systems. In a collection of papers she championed the case of Yoruba logic. The story was one of a battle between two incommensurable competing knowledges, where heroic individuals



(teachers) resisted colonisation by an invasion of Western knowledge and upheld indigenous knowledge. Yoruba educators responded to her findings with wry amusement. The problem with this relativistic view was in the translation of theory into policy, and it was here that she realised the flaw in her argument.

The existence of these two logics opposing each other in the imposition of/resistance to colonizing suggests that a proper anticolonialist cultural policy here would be to maintain the purities. Yet what sort of education is that? An abhorrent apartheid of numbering has no place in mathematics education. What I had spent so much time and effort in elaborating - two logics- now seemed to be prescribing policies that were both wrong and appalling. It becomes apparent that the critique is morally irresponsible. (Verran 2001: 27)

The West, through its colonial and post-colonial policies and through anthropological study, has repeatedly backed the ideal of development that is relevant to the African situation and that realises the potential of indigenous local knowledge. Questions of relevance have been asked of the African school curricula since the days of colonialism and numerous attempts to increase the relevance have been made with little success. Colonial attempts to blend local traditions with the modern school curriculum were rejected by the Tanzanians (see chapter two). These curricula were designed to be relevant to the current reality at that time; to teach agriculture on the basis that agriculture was the predominant economic activity of most Tanzanians, to teach in Kiswahili on the basis that it was the language most widely spoken, to teach vocational skills on the basis that places in post-secondary education were limited and that it was preferable for school leavers to have employable skills. They did not take into account the aspirations of parents, students and educators to escape the current reality and to prepare students for 'modern' lifestyles.

As Foster demonstrated in Ghana (Foster 1965), a secondary curriculum that aims at providing skills 'relevant' to the local economic situation does little to alter the employment aspirations of students. For Tanzanian students and teachers, the knowledge of titration, coal gas and other content of the science curriculum was highly relevant as it helped the students to answer examination questions and, for the fortunate minority, enabled them to go onto the next stage of education with

improved employment prospects. It was seen as necessary knowledge for facilitating the path to a modern sector job. Dore (1976) sees the pursuit of apparently irrelevant academic studies as an outcome of an economic environment in which there are very few formal sector jobs. But this preference for the academic science over a more locally 'relevant' curriculum may not simply be due to what Dore refers to as the 'diploma disease'. It can also be seen as an expression of what Tanzanians felt was relevant to the world in which they aspired to live.

Efforts by outsiders, and by some Tanzanian thinkers such as Nyerere, to promote the local often ignore that the locals aspire to be part of what they see as a global modernity. Western fears of ethnocentricity and cultural imperialism can lead to the imposition of 'locally relevant' development, but 'locally relevant' alternatives are often considered to be second rate and undesirable by the locals themselves. We should ask whether such development is truly locally relevant, when local aspirations are to escape the life to which the development is adapted. In Western nations, the image of modernity is based on local realities. Tanzanians have tended to look to affluent foreign societies for the image of modernity that they aspire to. So, whereas in Western cultures the aspirations have tended to be relatively close to local realities, in Tanzanian society the distance between aspiration and reality is much greater. The separation of aspiration and reality can be seen as a symptom of living in a less developed country within a globalised world. The education system in Tanzania has been shaped by aspirations of modernity, and by the gulf between these aspirations and the local reality. This thesis looks at the effects that this gap between aspiration and reality has had on pedagogy within secondary science in Tanzania.

## **Chapter outline**

Chapter one delineates Western models of pedagogy and compares these with the type of pedagogy found in many less developed countries. Differences between Western pedagogy and the pedagogy in non-Western contexts are sometimes interpreted as deficiencies of the non-Western systems. However, comparison of student achievement in international achievement tests raises questions regarding

assumptions about the efficacy of Western style pedagogies. Other cultures, notably East Asian ones, have been shown to have alternative teaching styles that appear to be highly effective. Features of pedagogy in non-Western contexts that differ from Western models should therefore be treated as alternatives rather than deficiencies.

International comparisons of pedagogy reveal that pedagogy is highly cultural and not purely a technical enterprise. Western pedagogy carries with it Western cultural assumptions and tastes. It is not a universally applicable and culturally neutral technology. When Western pedagogy is introduced into African contexts there is considerable potential for cultural conflict to occur. The chapter examines areas of cultural conflict described in the literature: collectivism versus individualism, the authority role of the teacher, school science versus the African world-view and the authority of scientific knowledge. Comparisons between oral and literate societies are explored in terms of the different approaches to knowledge sources and learning. The treatment of text in different societies may explain some differences in pedagogy. However, the chapter points out that science itself is a cultural activity and contains extensive tacit knowledge: ways of thinking and practical skills that cannot be learned in a codified form from written sources, but instead need to be passed on through personal contact. The availability of this tacit knowledge of science may also be an important determinant of pedagogy.

Against this backdrop of different cultures having their own locally appropriate pedagogies, the development of science education in Tanzania could be seen as a legacy of colonial and neo-colonial policies, with Western knowledge and pedagogic styles being imposed on the Tanzanian context to the detriment of local educational practices and knowledge systems. However, the history of educational development in Tanzania gives a different picture. The pressure for adaptation and localisation of the curriculum has largely come from outside whereas most Tanzanians<sup>2</sup> have tended to favour Western models of schooling and to reject local models. Policies of adaptation in colonial times met with local resistance from parents and students who aspired to modern, Western style education rather than education adapted to what

---

<sup>2</sup> Tanzania was formed from the union of Tanganyika and Zanzibar in 1964, but for simplicity within this thesis I refer to the inhabitants of Tanganyika as Tanzanians throughout the thesis.

policy makers saw as local realities. Nyerere's *Education for Self-Reliance*, central to educational policy throughout much of the post-colonial era, can also be seen as a form of adapted education. Like the colonial policies, this met with resistance that prevented it from being fully implemented. The rejection of adapted education by rural Tanzanians may have been because the policy makers' ideas of 'local realities' were based on a romanticised and outdated image of Tanzanian rural life.

Educational policies have been adapted to the Tanzanian context in terms of both the structure of the education system, and in terms of the curriculum. Chapter two explores how various policies for adaptation have been implemented and received by Tanzanians since colonial times up to the new millennium. It considers the impact that educational expansion has had on pedagogy. It also looks at how the tension between the desire for modernity and the pressure for indigenisation has played out in a context of extreme resource scarcity, both in terms of human and physical resources. The chapter explores some of the interventions around the turn of the millennium, that have impacted on secondary science education, notably the Secondary Education Development Plan (SEDP) and the introduction of the idea of "participatory teaching methodology", or *njia shirikishi*, from Western sources into teacher training.

The history of education in Tanzania highlights the problems with universalistic assumptions that can lead to blind acceptance of Western hegemony. But it also points to the dangers of a relativistic approach that, in its avoidance of Western ways of thinking, looks to outdated models of African thought and focuses on the exotic. Chapter three discusses how I negotiated the balance between these two problematic extremes within my methodology. As a Westerner researching education in Africa, there was an epistemological and ethical need to ensure that the views of Tanzanians were taken into account throughout the research process. In order for this to take place it was necessary to be flexible in my methodology so that informants could influence the design of the data generation process while I was in the field. The research questions were developed as a result of my previous experience working with SESS and a consideration of the literature and initial findings in the field. The

chapter explains how the research sites and informants were selected and how data was generated and analysed. The core set of data consists of a set of lesson observations and post observation interviews. I describe how the discussions during the interviews were shaped by the emerging findings. The generalisability, validity and objectivity of the research findings are also discussed.

Chapters four and five present the data and an analysis of the findings in terms of the pedagogical models that teachers use to inform their practice. Chapter four focuses on the knowledge sources that science teachers use. I discuss teachers' schooling, their training (both the official and the unofficial curriculum) and the knowledge sources that they draw on whilst teaching. The recruitment and training of teachers clearly demonstrated the gaps between aspiration and reality within science education in Tanzania. The training was based on assumptions that trainees had sound content knowledge, but this was generally not found to be the case.

Many teachers claimed that the students were an important source of knowledge within the classroom. I therefore explored the knowledge sources that students drew on including official textbooks and hand-copied notes, which I refer to as the 'hidden textbook'. Experiential knowledge was notable by its absence within the discourse on knowledge sources. Scientific experiments and practical work were treated as additional curricular content rather than as ways of generating knowledge through experience.

Chapter five looks at the delivery of science lessons. Definitions and formal categorisation were found to be central to the way that scientific knowledge was organised and presented. Observed lessons were predominantly oral and there was extensive student involvement through whole class and group discussions. Students raised questions as well as answering them. Role-plays and competitions were also used, but practical work was rare. Teachers avoided telling students that they were wrong, preferring instead to ignore answers that they considered dubious. Very little written work was carried out in class or set for homework. Teachers' main rationale for setting written work was for assessment rather than for learning; however oral



assessment dominated as a tool for evaluation of the learning taking place in individual lessons. Internal examinations and the national examination rewarded recall of definitions; so the teaching style can partly be seen as a pragmatic response to this. The dominant pedagogical model that emerged from the data is one in which the science curriculum was seen as a set body of codified knowledge that needed to be learned verbatim. This text was treated almost reverentially, as a sacred text, and was carefully conserved by the teaching-learning process. Learning was often seen as a one step process involving the memorisation of the sacred text. Whilst the authority of the teacher did not appear to be a significant barrier to the adoption of the form of learner-centred pedagogies (e.g. use of group-work), the authority of the text remained a barrier to their full adoption.

Chapter six explores the roots of this pedagogic culture and develops a theoretical model for how the culture was sustained. The teaching culture may partly be explained by the fact that much of Tanzanian society was, until relatively recently, predominantly oral, with a high value for the community over the individual. However, as argued in earlier chapters, it is erroneous and ethnocentric to equate Tanzanian culture with that of pre-colonial Tanzanian societies. This chapter instead explores how Tanzanian images of modernity have influenced the development of secondary science education. It focuses on three major influences: the rapid expansion of the school system, the inclusion of laboratory-based science syllabi in the curriculum, and the use of English as the medium of instruction. There has been a wide gulf between popular aspirations (for mass schooling, for scientific literacy and for fluency in English) and the socio-economic realities in Tanzania. Efforts to achieve these aspirations have exacerbated shortages of human and physical resources. As a result, science education in Tanzania has developed in a context of information scarcity. The chapter explores how this context could lead to the adoption of survivalist educational practices that strengthen the authority of the sacred text. It gives three examples of observed practices that offer promise in terms of escaping the sacred text and enabling more meaningful learning to take place.

In the concluding chapter I return to the research questions developed in the first three chapters. The dominant pedagogical model found among the teachers in this study prioritised the preservation of a sacred text over the development of personal meaning. It is argued that this approach to learning is typical of a context in which there is very limited access to sources of information on the subject that teachers are attempting to teach. This situation of information scarcity can arise when the aspirations of a society regarding the culture that it wants to promote in its children is far removed from the local realities. The chapter considers how participatory teaching methodology has been adopted and adapted within this context. It identifies examples of locally developed practices in teaching and learning of science that have potential to improve the quality of science education in Tanzania.





# 1. Pedagogy, Culture and Science

The holy grail in the study of education reforms in postcolonial states is to explain the spectacular failure of progressive policies that sought to alter classroom pedagogy through what is widely described as 'learner centred education.'

(Jansen 2005a: 105)

A fundamental question of this research from the outset was: what do Tanzanian teachers see as 'good teaching'? Or, in the terms used by Olson and Brunner (1998), what 'folk pedagogies' are predominant among Tanzanian science teachers? These folk pedagogies are dependent on teachers' ideas about the learning process (their folk psychologies), and their ideas and beliefs about what students should learn in secondary science, what we might call their 'folk curriculum'. This will depend on teachers' local understandings of the nature of scientific knowledge. A further aim was to investigate whether there were areas of conflict or congruence between Tanzanian teachers' folk pedagogies and the pedagogies promoted by teacher education and curriculum development through Western agencies. Whilst this study is not explicitly comparative, there is an implicit comparison between what is *promoted* (but not necessarily practised) as good pedagogy by Western educationalists and what is thought to be good pedagogy among Tanzanian teachers.

This chapter looks at Western conceptions of good pedagogy and considers the universality of these conceptions by comparison with alternative perspectives from non-Western world-views. This raises the fundamental question of "what is quality education?" in terms of pedagogy. When teaching practices in non-Western contexts are very far from the Western conceptions of good pedagogy does this mean that they are of lower quality and far behind in development? The chapter explores Beeby's stage model (Beeby 1966) of educational development and considers its weaknesses based on its universalist assumptions. More recent research (Alexander 2000) has explored the possibility that international differences in pedagogy are due to alternative, but equally valid conceptions of good teaching.

Within the African, and particularly the Tanzanian context, few would argue that current teaching practices represent quality education and there is general consensus

on the need for change. The involvement of Western aid agencies and the pervasive linkage between Western culture and modernity in the eyes of Tanzanians mean that the direction of the change has tended to be towards models dominant in the West (see chapter two). Taken from either a universalist or a relativist point of view, interventions for educational development need to take the current culture of education into account. This chapter looks at potential areas of conflict between Western models of pedagogy and African culture, considering the particular case of science education.

### **1.1. What is Good Pedagogy? Western models**

Teaching based on the transmission of facts and learning based on memorisation has long been seen as an undesirable pedagogy within Western culture. It is implicitly criticised in Rousseau's *Emile* (Rousseau 1762/1974) and ridiculed by Dickens in *Hard Times* (Dickens 1854/1955). However, it was not until after the Second World War that an alternative paradigm, largely based on the empirical work of Piaget in cognitive development and on Vygotsky's socio-constructivist theories of learning, began to impact on classroom practice in the UK (Jenkins 1979). Whilst there has been a tendency in recent decades to espouse the work of Vygotsky and to eschew Piaget,<sup>3</sup> there is considerable overlap between their work and areas of difference can be seen as complementary rather than conflicting (Shayer 2002). Both had a profound influence on European discourse on learning and pedagogy throughout the latter half of the twentieth century.

Central to the theories of both Vygotsky and Piaget is the idea that concepts are constructed within the mind of the learner and the term *constructivist* is often applied to learning theories based on their work. Learning is not simply inputting of knowledge, but involves an active thinking process in which the new knowledge is equilibrated with the learner's existing pre-knowledge. Learners' pre-knowledge includes concepts that they have constructed themselves based on experiences both within and outside school. According to Piaget (1978), when the new knowledge

---

<sup>3</sup> See for example Donaldson 1978

conflicts with the pre-knowledge, the learner is compelled to reorganise their existing mental structures and this reorganisation enables the learner to process more complex information in the future. Learning is linked to the development of cognitive structures that equip the learner to think more powerfully. Expertise depends on the quality of learning rather than just the quantity of knowledge retained.

The idea that children actively construct their own learning led to the development of discovery methods of teaching. This was particularly influential in science education. Curricula and materials developed in the 1960s, such as *Nuffield Science*, were based on the idea of pupils as apprentice scientists, making sense of the physical world through experimenting for themselves (see for example Nuffield Foundation 1966. See also Jenkins 1979; Waring 1979). A teacher using discovery methods of teaching may, for example, provide pupils with magnets and an assortment of materials and let them explore and experiment for themselves. The teacher and teaching materials provide questions aimed at drawing out the learners' interpretations of the observations and hence the laws of magnetism through a plenary discussion. This method is supported by experimental findings that indicate the apparently paradoxical result that the more effort made to teach problem solving explicitly, the less effective the learning, as direct instruction in problem solving denies the learner the opportunity and motivation to work out the solution for themselves (see, for example the work of Kuhn & Agelev in Adey and Shayer 1994). From observations of mothers teaching infants how to solve a puzzle, Wood (2000) describes how teaching strategies that involved the mother demonstrating how to do it first or giving direct verbal instructions were less successful than strategies that allowed the infant to try things out, only giving guidance when it was needed. Vygotsky argued:

Practical experience also shows that direct teaching of concepts is impossible and fruitless. A teacher who tries to do this usually accomplishes nothing but empty verbalism, a parrot-like repetition of words by the child, simulating the knowledge of the corresponding concepts but actually covering up a vacuum. (Vygotsky 1934/1962: 83)

Instead of direct teaching, Wood (2000), following from Vygotsky, suggests the strategy of scaffolding, by which he implies a process of giving temporary support

and guidance to the learner's thinking, enabling the learner to construct concepts for themselves. Key to this paradigm is the idea that new valid knowledge can be derived from what we already know, an idea that Olson and Brunner (1998) consider as foundational to the renaissance and the coming of the age of reason within Western thought.

Both Piaget and Vygotsky link the process of conceptual learning with the process of cognitive development (Shayer 2002). The value of the school curriculum is therefore not merely in its content, but in the development of thinking ability that it nurtures in the learners. Within this model, "good teaching" should aim at developing thinking skills that can be transferred to new situations (Adey 1997) and the question of what is relevant in terms of the school curriculum should be determined by what concepts help to develop generic, transferable thinking skills rather than content directly related to the lives that learners will lead after school. So, for example, learning to balance chemical equations could benefit someone even if they never need to balance a chemical equation outside school.

Within the constructivist model, the focus of learning is on the cognitive processes taking place within the minds of the individual learners. Pedagogical approaches designed around the construction of concepts within the minds of the learner are often referred to as learner-centred approaches and contrasted with teacher-centred approaches that focus on the transfer of knowledge from the teacher. Whilst teacher-centred pedagogy is often linked to Freire's "banking" metaphor for teaching (Freire, 1972), with the learner passively receiving knowledge from their teacher, learner-centred education is based on a construction model with the teacher providing scaffolding and support for the learner as he/she actively builds concepts by integrating new knowledge with what is already known. In the school context, the term "child-centred" has also been used, implying that teaching approaches should be adapted to the thinking and interests of children. According to Piaget's model of development, children's minds are not equipped to deal with highly abstract concepts and it has been argued that the science curriculum should be designed to ensure that concepts are not beyond the cognitive level of the learners (Shayer and Adey 1981).

Learner-centred, or child-centred models of pedagogy are also influenced by Western notions of democracy and the importance of individual choice and agency. Dewey's work (Dewey 1897; Dewey 1916/1966) has been particularly influential in this area, especially in American educational theory. Within democratic learner-centred classrooms, the curriculum should not merely be tailored to integrate with learners' pre-knowledge, but learners should have an active role in determining what is learned. The authority to decide what counts as valid knowledge to be discussed in the classroom is therefore transferred from the teacher to the learners.

Categorising different teaching techniques as either "learner-centred" or "teacher-centred" runs the risk of oversimplification into a false dichotomy, with the former often assumed to be "good" practice and the latter assumed to be "bad" practice. If the teacher lectures the class this would generally be considered to be teacher-centred. A lecture could stimulate reproductive learning, where the learner passively "absorbs" the knowledge imparted by the teacher, or it could be a thought provoking lecture in which the learner is invited or inspired to analyse or challenge the information being put before them. Similarly, activities that actively involve the whole class, such as carrying out practical work in science, might be labelled "learner-centred". But overtly active teaching methods can lead to reproductive learning if, for example, students are expected to follow a set of instructions in order to reproduce an approved set of results. Even a highly co-operative learning exercise with students working in groups to research and solve a problem, can lead to reproductive learning if the text-based knowledge sources available give an uncontested solution and no discussion or analysis are carried out.

"Good pedagogy" cannot simply be defined in terms of a list of learner-centred or co-operative teaching methods, but needs to take into account the approaches to learning that it encourages, and hence the quality of learning taking place. One model for analysing approaches to learning that has been developed is that of "deep" and "surface" approaches. Learners employing a deep approach treat new sources of information holistically and look for meaning by relating it to the wider context. Learners employing a surface approach focus on specific details of new information without attempting to consider any overall meaning or relation to other information.



Learners using a surface approach tend to have a conception of learning as a quantitative increase in knowledge through memorisation. Learners using a deep approach tend to see learning as a process of abstraction of meaning (Marton and Säljö 1984). Within Eurocentric thinking it may appear obvious that deep approaches are more desirable than surface approaches, but this preference for analysis is shaped by the way that literacy is deeply embedded within Western culture (Ong 1982/2002, see below) and is not necessarily a universal across cultures. The false dichotomy between learner-centred and teacher-centred teaching has arguably led to an over emphasis on analysis and an under emphasis on memorisation and direct teaching within Western contexts. For unproblematic knowledge, transmission teaching and memorisation can be the most efficient teaching/learning strategy (Perkins 1999).

Discourse on constructivist pedagogies is now becoming displaced by an emerging paradigm in which learning and cognition is seen as being situated in the context in which it occurs. Research into the thinking of child street vendors found that they develop their own strategies for dealing with mathematical problems involved in the vending process (e.g. Saxe 1988; Nunes, Schlieman & Carraher 1993 in Nunes and Bryant 1996). What was notable from the findings was the lack of transfer of mathematical problem solving strategies from the street context to school context and vice versa. Given that neither form of mathematics appears more transferable than the other, it is argued that both practical knowledge such as street mathematics and academic knowledge should be credited with equal value (Nunes and Bryant 1996). It has been argued that claims that schooling leads to superior cognitive functioning, as demonstrated by Piagetian-type testing on schooled and un-schooled subjects, are empty ones, as the type of testing employed measures the very skills that the schooled subjects have been familiarised with (Cole 2005). Schooling, argues Cole, trains students to privilege abstract thinking; but this type of thinking is not of any greater intrinsic value than the embedded thinking involved in street vending. Abstract, academic thinking is itself embedded within the context of the school. The idea that cognitive skills are highly context dependent is referred to as situated cognition (Brown, Collins and Duguid 1989). It is argued that knowledge is

both a product of, and dependent on, the activity and context in which it is developed and used.

If we are to accept the phenomena of situated cognition, teaching abstract scientific concepts that bear little relevance to every day life is a pointless exercise. In order for school learning to be useful it should focus on authentic, real life dilemmas (Butterworth 1992). Not only should the content of a subject be applications-led rather than theory-led, as in *Salters Science*<sup>4</sup> (University of York Science Education Group 2003), the learning and problem-solving process itself should more closely represent real life. Learning should take place through guided apprenticeship or legitimate peripheral participation (Lave and Wenger 1991). *Education By Design* (Antioch New England Graduate School 2003) is one of several programmes that uses these ideas, and students learn through discussion or research in a way designed to imitate how problems are approached out of school.

In this emergent paradigm of situated cognition, the process of learning itself is seen very differently than it is within the constructivist or banking models of learning. Svard (1998) argues that transmission teaching and constructivist, learner-centred education are based on a conception of learning as acquisition of knowledge and skills whereas the emerging paradigm sees learning as participation.<sup>5</sup> In the learning-as-acquisition model, learning and using the skills and knowledge learned are two separate processes. Within the participation metaphor, learning and practice are inseparable, and the goal of learning is seen as becoming a participant within a community of practice. Eraut describes the interdependence of learning and practice as follows:

---

<sup>4</sup> *Salters GCSE Science* is a course for 14-16 yr olds in the UK, with its own examination that is nationally accredited. Topics are designed around everyday life and the science is introduced as it is needed to understand the topic of study. See <http://www.york.ac.uk/org/seg/gcsescience/pages/>

<sup>5</sup> It should be noted that the term "participation", as used by Svard to describe the metaphor for learning on which ideas such as legitimised peripheral participation are based, has different origins from the term "participatory teaching methodology" used by Tanzanians to refer to a broad spectrum of constructivist teaching methodologies, although there is some overlap in the pedagogical approaches covered. See chapter two.

Learning knowledge and using knowledge are not separate processes, but the same process. The process of using knowledge transforms that knowledge so that it is no longer the same knowledge. (Eraut 1994: 25)

Within this paradigm 'good pedagogy' is much closer to apprenticeship than traditional classroom learning.

The emergent paradigm is less focused on the individual. Instead, the skills and knowledge of the whole group are considered. Intelligence and cognition are seen as things that are distributed across a social group (Case 1998) and the technologies used to facilitate thinking (Bruner 1996; Perkins and Grotzer 1997). Cognition is seen as something that takes place through people interacting with each other and with their cognitive tools. The idea of distributed cognition highlights the importance of the peer group in the learning process. Learning is seen as a communal enterprise, not an individual one. It also stresses that cognition is dependent on the technologies and tools available. These can include symbol systems, writing devices, computers or the internet.

A similar strand of thinking along the participation metaphor is the idea of co-operative learning, based on the work of Dewey and Vygotsky. In Vygotsky's model of cognitive development (Vygotsky 1934/1962), meaningful learning only takes place when a learner is interacting socially with others.<sup>6</sup> A catalogue of teaching and learning approaches has been developed that encourage co-operation and sharing of knowledge between learners (Sharan 1994). Co-operative teaching methods make extensive use of small group work, and employ strategies to encourage intra- and inter-group exchange of ideas, information and learning.

Western ideas of "good pedagogy" remain fluid and highly contested. The use of the term "Western" itself may be misleading as the model that has developed in many European countries has drawn on influences from around the globe. Whilst the influence of specific educational thinkers has been mentioned, it should be noted that

---

<sup>6</sup> For this reason Vygotsky's model of learning is often referred to as social constructivism to distinguish it from the more individual-based construction of meanings of Piaget's model of learning.



the way that educationalists have interpreted their work has been influenced by the values of the wider society. The discussion above focuses on the models of 'good pedagogy' as promoted by educational literature. There is often considerable distance between these and the perceptions of good pedagogy held by practising teachers (Calderhead 1996), what are sometimes referred to as their folk pedagogies (see section 1.3 below). Given these caveats, we can say that Western pedagogical models have, in the past, focused on the individual needs and learning of the child. But there is an increasing call for learners to be considered as a community, and for learning to be seen as a process that takes place through the interactions within that community and with the technologies and information sources available. Meaningful learning involves the learner, either as an individual or as a member of a learning community, using their existing knowledge to generate new knowledge and to make sense of new information through analytical processes.

## **1.2. International Perspectives on Pedagogy**

In his book *The Quality of Education in Developing Countries*, Beeby (1966) proposes a model of educational development involving stages through which all educational systems progress in a linear manner. At the lowest stage of growth, the unorganised *Dame School*, Beeby characterises teachers as "ill educated" and "untrained" with learning involving memorisation of "relatively meaningless symbols" (1966: 72). Training the teachers brings the system to the next stage of *formalism*, characterised by a rigid syllabus and rigid methods. Development beyond this through *transition to meaning* is dependent on further formal education of the teachers. In the final stage, meaning and understanding are stressed, problem solving and creativity are fostered and a variety of activity methods are used in teaching. The pedagogy of the *meaning* stage is in line with constructivist theories of learning. Beeby argues that all education systems progress through these stages. While the rate of progress through the stages can be accelerated, systems cannot 'leapfrog' any one stage of the model. Teacher knowledge is central to Beeby's model and the pedagogical approaches employed are seen as dependent on the level of training and the content knowledge of the teaching force. Before the teachers can start to teach

through activity methods they need to be secure in their content knowledge. Verspoor and Leno's elaborated version of Beeby's model (Verspoor and Leno 1986) also includes the availability of textbooks and other materials as a necessary precursor for progression to the later stages. They rename the stages according to the teacher behaviour as *unskilled*, *mechanical*, *routine* and *professional*.

A problem with Beeby's model is that it gives a linear pathway for educational development, progressing from a default low quality starting point towards an imagined ideal educational system based on the assumption that Western<sup>7</sup> education is a good model.<sup>8</sup> Deviations from this Western ideal are seen as symptomatic of educational underdevelopment. In recent years the results of various cross-national performance tests such as the Trends in International Mathematics and Science Studies (TIMSS) have led policy makers and researchers to question the assumption that pedagogical approaches in vogue in the West lead to better learning outcomes. The high scores of students in the Pacific region and Russia compared to the more mediocre performance in the UK and USA prompted a number of studies that compared pedagogical approaches in these different national contexts.

In a study of culture and pedagogy in primary schools in five nations, Alexander (2000) identified significant differences in pedagogy that he claimed could be traced to culturally specific traditions and theories of teaching. The greatest contrasts appeared to be between teaching in India and in the United States. In India, lessons were based largely on oral work with teachers asking mainly closed questions. There was a strong emphasis on subject matter. The American lessons were more dominated by writing and reading exercises, the teachers' questions were more open and there was a much greater emphasis on affective and behavioural issues. The pattern in Russian classes shared many similarities with the Indian classrooms, with both fitting closely to the authoritarian, teacher-centred paradigm, and yet grade eight Russian students scored higher than the USA in the TIMSS achievement tests

---

<sup>7</sup> Beeby was from New Zealand, which, whilst neither "Western" nor "Northern" in the geographical sense, can be considered to be culturally Western due to the ethnic origins of the majority. The term "Western" is used here to refer to the predominant culture of Western Europe, North America, New Zealand and Australia.

<sup>8</sup> See Guthrie (1980) for a discussion of the critiques of Beeby's model.

conducted in 1995 and 1999 (Mullis, Martin et al. 2004). It would appear that some more typically 'teacher-centred' pedagogical approaches, found in Russian classrooms, constitute highly effective teaching strategies despite not fitting the "child-centred" paradigm of the West.

Stigler and Hiebert's comparison of mathematics teaching in Japan, Germany and USA (Stigler and Hiebert 1999) found that in Japan there was a much greater focus on the lesson content, on the mathematics, whereas in the USA the teacher's focus was primarily upon the learner. Some of the observed Japanese mathematics lessons included long periods of lecturing while others included drilling to ensure that learners committed mathematical principles to heart; but these activities were followed by problem solving where students were given challenging problems to solve using the information that they had just been taught directly. Lessons in the USA were learner-centred in that they assumed that learning mathematical skills was essentially dull and that the mathematics needed to be made more interesting through the inclusion of real life examples, such as measuring the circumference of a basketball (1999: 89). American teachers were also found to provide help to their students at a much earlier stage than Japanese teachers. American classes solved problems individually whereas Japanese classes often worked together in groups to solve problems. The Japanese students were able to cover much more complex mathematics than the American students.

The Western model of science education has often assumed that discovery learning and hands on practical work are essential for quality learning to take place and yet many Newly Industrialised Countries (e.g. South Korea, Singapore) managed to achieve major development in national capacity in science and technology without these pedagogical aspects having been a common feature of science education (King 1991). It was notable the three highest scoring countries in the 2003 TIMSS were also reported to have above average amounts of lecturing and below average amounts of practical activities related to enquiry science learning (Mullis, Martin et al. 2004)

In African contexts, which do not have such a long history of formal education or such enviable performance data,<sup>9</sup> there is often an assumption that “West is best” and both donors and national policy writers have tended to promote pedagogical approaches developed and favoured outside of Africa (Brennan 1990; Serpell 1993; Semali 1999).

### **1.3. Pedagogy as Culture**

Based on Bloch’s (1998) definition of culture as “that which needs to be known in order to operate reasonably effectively in a specific human environment”, the knowledge that teachers bring to a classroom which has been derived locally can be seen as an element of their culture. How this knowledge shapes the teaching process can be seen as the cultural influence on pedagogy. The teaching practice will depend on teachers’ local knowledge and beliefs about learning and their knowledge and beliefs of what should be learned. These two areas of knowledge and belief inform local models of good pedagogy, what are referred to here as folk pedagogies.

Olson and Bruner (1996) base their idea of folk pedagogy on the concept of folk psychology, which is commonly attributed to Wundt (1916).<sup>10</sup> Folk pedagogy refers to our everyday, intuitive theories of how people’s minds work. These lay theories are rarely made explicit, but influence our interactions with others. Following from Wundt, Olson and Brunner argue that folk pedagogies “reflect certain deeply engrained cultural beliefs about the mind” (1996: 10). This strong cultural element means that different folk pedagogies will be found among different cultures. Applying this idea to education, they write of folk pedagogies as the lay theories that we all use in teaching, whether a mother teaching their child or a university professor teaching her students. If folk psychology refers to our culturally engrained beliefs about how children learn, we might also speak of a folk curriculum as the lay concept of what is to be learned in schools.

---

<sup>9</sup> Botswana, Ghana and South Africa, the only participating countries from Sub-Saharan Africa, all came at the bottom of the TIMSS 2003 science assessment by quite a long way (Mullis, Martin et al. 2004).

<sup>10</sup> Wundt himself pointed to earlier uses of the term “Völkerpsychologie” (folk psychology) which he described as having entered German discourse in the mid 19<sup>th</sup> century.

Whilst the term “folk” has condescending connotations, it is used in this thesis, as it is used by Olson and Bruner, to refer to the theories of mind that all people hold. It is not meant to imply that these theories are primitive or unsophisticated. The word “*völk*” in German, from which the term folk psychology is derived, is not exactly conceptually equivalent to the word “folk” in English. “Popular” may be a more accurate translation, but I have used the word “folk” here to be consistent with the literature. Like other educators world over, I hold my own folk pedagogy and this thesis has largely arisen as a comparison between my folk pedagogy and that of Tanzanian teachers.

An individual’s folk pedagogy may evolve with exposure to conflicting pedagogic models that they are exposed to, through teacher training for example, but will largely be shaped by that individual’s own cultural experiences within schools and within the wider society. Extensive exposure to explicit theories of learning, such as the work of Piaget, may alter common folk pedagogies over time. As academic models become popularised, they may gradually become assimilated into folk models. However, whilst the theoretical content of teacher training courses might consist largely of “international” pedagogic models based on these explicit theories, local folk pedagogies will also depend on the local cultural context. Just as a constructivist view of learning stresses the importance of understanding children’s own conceptions of reality, we also need to consider teachers’ folk pedagogies when introducing new pedagogic models.

Beeby’s model of pedagogical development discussed above assumes that there is an ideal pedagogical approach that all cultures should work towards. Pedagogical approaches are treated as independent of the cultures in which education takes place. Alexander’s work on pedagogy and culture (Alexander 2000) questions this assumption. Pedagogical techniques developed in the West may not necessarily work in different cultural and economic contexts (Fuller and Clark 1994). As Sadler observed over a century ago:



We cannot wander at pleasure among the education systems of the world, like a child strolling through a garden, and pick off a flower from one bush and some leaves from another, and then expect that if we stick what we have gathered into the soil at home, we shall have a living plant. (Sadler 1900/1979: 49)

Stigler and Hiebert argue that teaching is a cultural activity as it is learned primarily through informal participation over long periods. They concur with the opinion of a broader literature (e.g Calderhead 1996; Entwistle, Skinner et al. 2000) that the most significant part of teacher knowledge is learned through their experience as students, teachers and parents rather than through teacher training programmes. Treating pedagogy as a culture rather than a set of techniques means that the adoption of new elements will depend on how well those elements integrate with the current pedagogical culture and with the wider cultural context in which teaching is embedded. As Sadler's analogy indicates, educational cultures develop as integrated wholes and are adapted and suited to the local environment in which they have grown. Grafting on an isolated aspect of a foreign teaching culture, such as a particular pedagogical technique, may result in rejection by the educational system or by the wider society. For example, in Stigler and Heibert's study, one American teacher participant attempted to employ the Japanese approach of setting his class a complex problem without guidance. He experienced strong resistance from his students (1999: 99). Egyptian teachers returning from an in-service course in the UK were frustrated in their attempts to introduce new pedagogical approaches and encountered resistance from both students and other staff (Johnson, Monk and Swain 2000). Mbilinyi (1979b) reports that Tanzanian secondary students often objected to more creative, problem-solving and co-operative approaches to teaching.

As Tabulawa (2003) points out, learner-centred pedagogy is not value free, but carries with it considerable cultural baggage of the Western contexts from which it has emerged. In the West, learner-centred pedagogy is considered as equitable as it seeks to tailor education to the experiences and needs of the individual learners. It aims to avoid the privileging of elite discourse by fostering a democratic approach to knowledge construction. In the Pacific Rim countries, learner-centred pedagogy is considered to be less equitable than teacher-centred learning (Reynolds 1999). A child's own knowledge and experience will depend greatly on their socio-economic

background and so if these are used as the basis for learning, children from disadvantaged backgrounds will be further disadvantaged in their learning experiences. With teacher-centred education, all children are given equal access to the knowledge of the teacher. Primary teachers in Tanzania used a similar rationale to explain why they positioned “pupils writing/reading about their own experiences” near the bottom of a ranking of “ways of helping pupils learn” (Mulhall and Taylor 1997: 22,32). The teachers said that things that happened in pupils’ home lives were private and sometimes confidential, and that pupils coming from poorer backgrounds might feel an inferiority complex if asked to discuss their home experiences.

Whether one takes a view that all educational systems are on a common path towards an ideal pedagogy or that different pedagogies work well for different cultures, ‘what works’ in terms of teaching style, is highly dependent on the pedagogical culture in schools and the wider culture in society. There is a danger that highlighting cultural differences can be used to justify the promotion of “appropriate” interventions by powerful outsiders such as multilateral and bilateral development agencies (Tikly 2001: 254). The tension between the imposition of what is considered appropriate education (culturally and otherwise) and the pragmatic acceptance of the hegemony of dominant forms of knowledge is explored in the following chapter; but here we consider potential areas of conflict between Western and African pedagogical cultures.

#### **1.4. Areas of Cultural Conflict between Western Pedagogy and African Cultures**

In his analysis of the interaction between African culture and science education, Jegede identifies five categories of socio-cultural influences (Jegede 1995); namely goal structure (cooperative or individualistic), authoritarianism, traditional world-view, the sacredness of science and societal expectations. The first two influences are important factors for the formation of teachers’ generic folk pedagogies and are discussed in more detail below. The traditional world-view and the sacredness of science can influence teachers’ understanding of the nature of scientific knowledge



and contribute to their folk curricula. At an early stage in the research it became apparent that specific African beliefs about the world appeared to have little influence on what took place in science lessons, but beliefs about the nature of scientific knowledge and its sacredness proved a more valuable area of investigation. One possible explanation for the differences between Western and Tanzanian understanding of the nature of scientific knowledge is the differing extents that literacy has influenced the cultures. Further understanding of the differences can be gained through consideration of the tacit dimension of scientific knowledge and the extent to which this knowledge is distributed within the science education community.

Jegede's fifth category – societal expectations, is explored further in the following chapter, which looks at the conflict between modernity and adaptation in education in Tanzania through an historical perspective.

#### **1.4.1. Collectivism Versus Individualism**

Both Nyerere (1967) and Kenyatta (1961) criticise Western style formal education for its focus on the individual and contrast this with the focus on the community in African traditional education. The *Education Sector Strategy* (World Bank 1999a: 8) uses the word 'individualized' in describing the modes of learning considered to be advantageous. Focusing on the individual in education is sometimes seen as an essentially Western idea. Nyerere, in his *Education for Self-Reliance*, claims that the emphasis on the individual in education came from British capitalist culture. He calls instead for education that emphasises co-operative endeavour (Nyerere 1967).

Rousseau points out that there is an essential conflict between educating a member of society and educating the individual.

Forced to combat either nature or society, you must make your choice between the man and the citizen, you cannot train both. (1762/1974: 7)

A citizen is trained to conform to norms, to the accepted wisdom of those that have come before, whereas Rousseau's Emile is trained to think for himself and to

develop according to his own 'nature' rather than being moulded by society. However, this training, and the type of thinking it produces, involves critically examining and challenging accepted norms. It can therefore lead to conflict rather than conformity with society.

Translated to the pedagogic level, the dimension of community versus the individual could be seen as one of teacher-centred versus learner-centred pedagogy. The teacher represents the community and, as a mature, enculturated member of that society, has access to its knowledge. In a socialising paradigm, the teacher is responsible for passing this knowledge on to the children so that they can become full members. However, in an education system aimed at developing the child's individual potential, the child's own experience and interpretation of that experience become central to the learning process.

As mentioned above, the term "teacher-centred" has been loaded with negative connotations and is often seen as synonymous with bad teaching. However, classes with teacher-centred teaching, in which the teacher is the controlling actor and the central point of the knowledge flow, do not necessarily entail passive students or lack of meaning. Renes (1970) reports observing a Tanzanian class which was teacher-centred, but in which the students were highly active. Teaching involving chorused answers encourages all students to participate. Alexander (2001) argues that the child-centred / teacher-centred dichotomy is false one and that there are many equally valid pedagogies. In a society with a higher value on the community over the individual, child-centred pedagogy may not be appropriate or easily enacted. It may be more appropriate to use "class-centred" teaching, in which the needs and participation of the class as a group are the focus of attention rather than the separate learners.

Foster (1969) argues that Nyerere's portrayal of traditional African culture is too idealistic and points to evidence that the emphasis on collectivism in pre-colonial African society was not universal. He argues that traditional society was organised for survival and not development, a point that highlights the tension between the

focus on society and the focus on the individual. An educational system that produces citizens who fit perfectly into a society and conform to it will sustain a static society. The citizens will continue to maintain traditions as this is what they have been educated to do. Mushi (1989) points to the static nature of traditional African education as one of its key weaknesses. The aims of education or other child rearing practices in agrarian communities will tend to foster continuity, obedience and co-operation. By contrast, urban-industrial societies of the West value autonomous decision making and freedom of choice and Western education systems tend to reflect this value system (LeVine and White 1986). Varkevisser (1969) noted that in Sukumaland,<sup>11</sup> urban parents were much more interested in their children's personalities and achievements than rural parents. She speculates that this may be because the futures of urban children are much more dependent on their personal achievement than those of rural children.

Kay (1975) points to the clash between local cultural attitudes of collectivism and the individualism of the New Primary Approach promoted in Kenya from the mid 1960s. The curriculum intervention promoted child-centred, active learning and small group activities. It advocated spontaneity, self-reliance and individualism. Kay argues that this did not fit well in a culture in which individuals generally submitted to the advice of the family and where children were unaccustomed to personal decision-making. This appeared to be something that teachers did not wish to encourage.

Whilst child-centred pedagogy espouses the treatment of the child as an individual, Eastern cultures of education tend to value community and conformity (Cheng 1994; Reynolds 1999). If, as Nyerere and other authors suggest, African society is more geared towards the community than the individual, then an African pedagogy is likely to share some related elements in common with Eastern rather than Western pedagogy. A Japanese funded in-service project in Kenya, the Strengthening Mathematics and Science at Secondary Education (SMASSE), has met with considerable success (Nagao 2003). It may be that the pedagogy being promoted,

---

<sup>11</sup> An area of Tanzania around Mwanza.

with its strong Japanese influence, has greater congruence with the Kenyan culture of education than is typically true of Western funded projects.

Group work is a common feature of Japanese classrooms (Stigler and Hiebert 1999) and also fits well with the ideas of co-operative learning. According to Nyerere and Kenyatta's images of traditional African education, group work could potentially have a high level of congruence with African pedagogic culture. But there are examples of resistance to the introduction of group-work in African classrooms from both teachers and students (Prophet 1995). One reason for this apparent conflict could be that the pedagogical culture of modern African schools is far removed from traditional African culture. Other research in Botswana indicated that group-work is popular among students (Lubben, Campbell and Dlamini 1995). Serpell notes that the peer group learning through group work, promoted through the Child-to-Child programme in Zambia, was so popular that students continued to use it after primary school as a mode of study. Several students formed study groups under their own initiative (Serpell 2005).

Models of learning based on the participation metaphor and ideas of co-operative learning may be more readily adopted in Africa than individualistic models such as those based on Piaget's work. However, modern African pedagogic culture is far removed from pre-colonial culture and there is potential for cultural conflict in the reverse direction from that described by Nyerere and Kenyatta, with a culture of individualistic learning within African schools, bolstered by the examination system and pressure for paper qualifications, coming into conflict with the promotion of ideas from the West of co-operative learning.

### **1.4.2. Authority of the teacher**

Another way in which the Western notion of learner-centred teaching may conflict with African notions of pedagogy is that it may be seen to undermine the authority of the teacher. The authority of the elders is a common theme in many traditional African societies. Jegede (1995) suggests that the role of the elder has been partially transferred to the teacher. In traditional formal education that took place during initiation ceremonies among many societies in Tanzania, the trainers were given extensive authority over the trainees. For example, initiates among the Ngulu were trained never to question instructors about anything strange and not to speak to instructors unless spoken to (Beidelman 1965). Kay (1975) suggests that attitudes of submission to elders have been a “cultural obstacle” to curriculum innovation in Kenya. Tabulawa (1997) points to missionary schooling as the root source of the authoritarianism observed in Botswana classrooms, but concedes that this was supported by Tswana culture.

Shumba (1999) describes how the Shona and Ndebele cultures of Southern Africa discouraged inquisitiveness in children. Asking questions was considered as disrespectful and ‘too clever’ (1999: 335). According to Shumba:

In African societies... (a)uthority figures are perceived as credible and infallible sources of information and solutions to problems, and hence it is virtually inappropriate for children to query knowledge or decisions of adults. (Shumba 1999: 349-350)

This contrasts with the modern Western ideal of inquiry based learning where questioning by the student is encouraged. Research into physics education in Nigeria found that students were uncomfortable about asking questions and some teachers actively discouraged it. One of the students who had been raised in the West did ask questions in class, but the other students considered this habit crude and the teachers said that he was ‘confused’ (Akatugba and Wallace 1999: 313).

This conflict between the position of the teacher as an authority figure and as an authoritative, infallible source of knowledge may partly explain why some Western pedagogical approaches have mixed results in Southern contexts (Fuller and Clark



1994). Child-centred practices could be seen to be undermining the teacher's authority. Nurturing the learners' ability to construct concepts for themselves and to bring their own knowledge to the classroom undermines the position of the teacher as the authoritative knowledge source. The reason why this problem may be particularly acute within the African context may lie within the modern education systems rather than within traditional African culture. Jansen (2005a) argues that teacher authority within African education systems is exceptionally fragile. Their limited education and training give them very little authority in terms of subject or pedagogic knowledge or credentialed qualifications. They have some adult authority due to their age and their appointment as teachers within the bureaucratic system of the school, but authority due to age alone is often limited in African secondary schools where students entering late into formal education are not always much younger than their teachers. Teacher authority is further threatened by large classes and poor resources. In contrast to the other research discussed, Jansen argues that it is this *fragility* of teacher authority, rather than its strength grounded in traditional foundations, that inhibits the adoption of learner-centred pedagogy within African classrooms. For teachers to adopt learner-centred pedagogies they must give up the little authority that they have to their learners, and yet this authority is necessary as it is all that the teachers have. In the Western contexts in which learner-centred pedagogies have developed, the teacher is supported by a much more robust body of content knowledge and a wide variety of resources, including texts, colleagues and electronic sources, by which they can supplement and reinforce their knowledge and hence their authority. Where these support systems are not available, learner-centred pedagogy may be less practicable.

#### **1.4.3. School Science and the African Worldview**

Various writers have suggested that African children are at a disadvantage to European children in learning science due to the wide cultural gap between their worldview and the worldview presented by science. Researchers have looked at both the worldview of the learners (Osaki and Samiroden 1990; Jegede, Fraser and Okebukloa 1994; Jegede 1995; Kesamang and Taiwo 2002) and of the teachers (Shumba 1996; Shumba 1999; Gwimbi 2003) and argue that indigenous African

beliefs present a barrier to the effective learning of science. Other writers comment that naïve conceptions of nature are remarkably consistent across cultures (Driver 1991) and argue that the worldview theory does not provide an explanation for why African children, and teachers, struggle with science (Dzama and Osborne 1999). The research on African teachers' explicit beliefs tends to indicate that most science teachers espouse scientific beliefs rather than traditional ones.

In a study on the influence of teachers' worldview on science teaching, 250 science teachers from a range of 5 different non-Western cultures were asked about their beliefs (Ogunniyi, Jegede et al. 1995). To the surprise of the researchers, the results were very similar across very different cultural contexts. Whilst this apparent uniformity may partly be due to the limitations of using quantitative survey methods to research worldviews, it also implies that at the level of explicitly acknowledged beliefs about magic, mysticism, metaphysics etc., there is little variation between science teachers across non-Western cultures. It would be interesting for the same survey to be carried out in a Western culture such as the UK where horoscopes are found in mainstream newspapers and where homeopathic remedies are available at any pharmacist. An extensive literature on science and religion (see for example Polkinghorne 1998) and my own personal experience as a devout Christian and a science teacher, would strongly suggest that belief in the supernatural is not an obstacle to learning or practising science. On the contrary, religion may provide a powerful inspiration for scientific study (Merton 1970).

One of the original intentions of this research was to examine the interaction between traditional beliefs and school science, but what was apparent from the literature and was soon verified in the field, was that the two areas were treated as totally separate domains that did not come into contact, and rarely conflicted. Aikenhead and Jegede (1999) describe this as "parallel collateral learning". They argue that for secured collateral learning, learners need to experience border crossings between their science and their home worldviews. The process of consciously resolving the cognitive conflict between the two domains is an important part of the learning process. Aikenhead and Jegede draw on examples of conflict from both Western and



non-Western contexts. Given the universality of the phenomenon of collateral learning (i.e. holding to scientific and supernatural beliefs at the same time), it is arguable that this is not an area of cultural conflict particular to the African context (Dzama and Osborne 1999).

#### **1.4.4. Authority of Knowledge**

A society's traditional beliefs about nature may be less influential on pedagogy than deeper underlying epistemological beliefs about scientific knowledge. Horton (1967) describes a key difference between African cosmology and Western science as the degree of reverence with which laws and rules are held. He claims that Africans hold their laws about nature with reverence whereas Western scientists are open to new theories that may challenge their existing ones. His argument underplays the level of reverence and faith with which Western scientists hold onto their accepted theories and presents the 'open' predicament of science and the 'closed' predicament of African cosmology as a binary when it may be better understood as a continuum. Science may be 'open' at the frontiers of exploration and discovery, but historical evidence of the resilience of faith in accepted foundational concepts in the face of contradictory evidence (Kuhn 1970) demonstrates that the scientific community has held central tenets as sacred, and has often been closed to alternative theories. Jegede (1999) refers to Africans having a sacred attitude to science. At a certain level of abstraction most scientists hold onto their laws reverentially. It may be more productive and less ethnocentric to view the differences between cultures not as whether or not they consider certain types of knowledge to be holy and unalterable, but at what level of abstraction they situate this authority.

Many formulae and laws taught in school science can be derived or deduced from more universal, underlying principles. For example, Boyle's Law and Charles' Law can both be deduced from the kinetic theory of gases. In Physics, many of the formulae in mechanics can be derived from Newton's laws of motion. Derivable laws tend to be taught at school for a variety of reasons. One is historic; generally the less universal laws came first and were then synthesised into universals. Another is

cognitive; universal laws tend to involve a high level of abstraction and the more context-specific laws may be helpful in constructing an understanding of them. A third reason is pragmatic; it takes time to derive solutions from 'first principles' and the derivable laws often provide useful shortcuts to solving common problems. The utility of these less universal laws and their historical precedence lead us to hold them with a greater degree of reverence than they may warrant. If the derivation from the underlying principle is poorly understood then the derivable laws become sacred and need to be learned verbatim. For someone who understands the underlying principle, the derivable laws become trivial and their limitations and lack of universality acknowledged, but the underlying principles (which themselves may be derived from more universal principles) are held with sacred reverence. The level at which science is held as sacred depends on what knowledge is taken as 'fundamental truths' and what is seen as a derivation of that truth for a specific application. In schools this will be dependent on the scientific understanding of the teacher.

In Bloch's study of how the Zafimaniry of Madagascar value knowledge (Bloch 1998), he identifies three distinct types of knowledge. Firstly there was knowledge of wild things that could be gained from observations of nature. This was considered childish knowledge. Secondly there was utilitarian knowledge, considered to be the domain of young adults. Thirdly, there was the wisdom of elders which was beyond question and otherworldly. It was not expected for people to understand this wisdom; they were expected to simply accept it as wisdom without analysis. Bloch found that written knowledge transferred to children during schooling was treated in a similar way to the wisdom of elders. It was considered to have much greater worth than knowledge that could be derived from observation. One can see how the use of discovery methods in science education would be antithetical to such a culture. According to Bloch's analysis, since school knowledge was treated as the "wisdom of elders", students were expected to learn it without understanding. If a learner has no understanding of the knowledge then he/she has no authority to translate it into different words.

Serpell (1993) points to the reverence for text as a key theme in the Zambian school culture. He suggests that the source of this sacred attitude to texts can be found in Western religious culture imported into the education systems of Africa through mission schools. The vast majority of schools in colonial Tanganyika were mission-assisted (Buchert 1994). Mission school education is often criticised for being catechetical (Thompson 1968; Kamwela 1977). The tradition of drilling children in a rote-learned litany in mission schools may have influenced the classroom culture throughout the education system, but it could also be argued that the more indigenised Koranic schools had, and continue to have, a similar influence (Cameron and Dodd 1970). The term Koran itself means recitation. LeVine and White (1986) identify memorisation of sacred texts as a common feature of education systems within agrarian societies where the aims of education tend to focus more on encouraging piety than on provision of utilitarian knowledge and skills. Faith involves submissive acceptance of texts rather than an analysis of evidence. Religious education, both Christian and Koranic, is based on sacred texts. Questioning or altering these texts risks heresy. The pedagogical approach taken often emphasises the word-perfect learning of scripture. This attitude might then be carried over to other texts, both by the pupil and by the teacher, so that a culture of learning is established in which text is treated as something to be memorised without alteration, rather than something to be analysed, interpreted and processed. When the subject knowledge of the teacher is fragile, textbooks become an authoritative knowledge source. A teacher who cannot discern what information in the text is derivable from underlying principles will need to submit to the authority of the text and maintain it in its verbatim form.

#### **1.4.5. Orality and Literacy**

Universalist ideas of pedagogy assume uniformity in the way people of different cultural backgrounds think and learn. Evidence from the fields of cognitive psychology and linguistics suggests that individuals in unschooled, oral societies think in very different ways from individuals in literate, schooled societies. Some researchers (Ong 1982/2002; Olson 1991) claim that literacy itself fundamentally

and irreversibly changes the way we think. Other research (Scribner and Cole 1981) indicates that the changes in ways of thinking may come about due to schooling rather than literacy alone. It should be noted that all of these authors point out that the thinking of unschooled, preliterate societies is not deficient or lacking rationality, but is based on an alternative set of criteria for what makes 'good' thinking. Research on categorisation among unschooled Kpelle showed that individuals were perfectly capable of allocating objects into typical Western formal categories (tools, fruit, clothes etc.) although they believed that this approach was a foolish and inferior one compared to categorisation based on functional pairings (e.g. orange with knife) (Glick 1974).

Whether the change is due to schooling or literacy, there is a general consensus that there are fundamental differences in the way that societies without schooling or literacy think compared to those with literacy and schooling. According to Ong (1982/2002), oral based thought tends to be aggregative rather than analytic. He argues that: "once a formulary expression has been crystallised, it had best be kept intact. Without a writing system, breaking up thought -that is, analysis- is a high risk procedure." (1982/2002: 39). Within an entirely oral culture learning involves committing to memory. Formulae and mnemonics are valued as they facilitate the memorisation process. In literate societies, interpretation is generally valued over replication. In terms of learning theory, reproductive learning of texts is considered to be superficial whereas analysis of text is seen as essential for meaningful learning. In oral societies learning of codified knowledge is a one-stage process involving memorisation, but literate societies tend to value learning that involves analysis of text. Learning becomes a two-stage process of inputting new information and then analysing it by comparison with existing knowledge.

Olson builds on Ong's theory to link literacy with objectivity (Olson 1991). He argues that once utterances are committed to writing the form becomes frozen and separated from the meaning, which is dependent on the process of interpretation by the reader. With oral utterances, the form and the meaning are linked, the words are not seen as separate from the objects or concepts that they refer to. The name is seen

as a fundamental aspect of an object rather than as a label applied to it. This may be why many oral cultures consider words to have magical powers and convey power over things (Ong 1982/2002). Horton writes of Africans having a “magical attitude to words” (Horton 1967: 157). Scribner and Cole (1981) report how some societies in Africa do not separate words from concepts as Western scientists tend to. In literate societies, words are seen as separate objects from the items that they denote. They are tags or labels rather than being intrinsic parts of the object. Literate societies are capable of metalinguistic cognition whereas in oral societies this is not generally the case.

Olson (1991) argues that the ability to judge the interpretation against the original text enables objectivity. He links the spread of literacy in Europe to the Reformation and the rise of modern science. Within religion the Bible represented the word of God whereas in science, nature was seen as the work of God. Both the reformation and the rise of science were dependent on the distinction between the ‘God given’ and its interpretation. Literacy, in other words, facilitates objectivity and enables scientists to distinguish facts from hypothesis and theory. Horton (1967) uses literacy to explain the rise of what he refers to as the ‘open predicament’ in Western societies that enabled the development of scientific thought. He compares this with the ‘closed predicament’ of African cosmology. Within the open predicament there is an acceptance that there may be alternative explanations and scientists have the confidence that enables them to say when they don’t know something.

The comparisons of cognition are generally based on empirical data from completely oral and highly literate societies. Whilst Ong claims that literacy brings about a fundamental change in cognition, he points to numerous elements of discourse in Western societies as residual aspects of orality and points to the tenaciousness of oral culture in the face of the onset of literacy (Ong 1982/2002: 113-114). Ong describes how texts are often treated as sacred in newly literate societies. This fits with Bloch’s finding that written knowledge among the Zafimaniry was attributed the same status as the “wisdom of elders” (Bloch 1998). Whilst literacy is widespread within



Tanzanian society<sup>12</sup> it is still a relatively recent technology and books remain a rare commodity. Apart from textbooks and religious texts there are virtually no books available outside of Dar es Salaam.<sup>13</sup> Whilst newspapers and magazines are rapidly becoming more widespread, the relative novelty and continuing scarcity of written material within Tanzanian society is likely to produce a very different pedagogical culture from that which has developed in contexts where literacy has been deeply engrained.

Eshiwani (1993) describes the colonial education system in Kenya as being biased against rote learning and failing to appreciate the role that it may have in indigenous learning approaches. He criticises the colonial education system as follows:

What was not realised by the educators then was that rote learning may be ineffective in a society where information is freely available for reference, and where good memory does not play an indispensable role in daily life; however, in a society where memory is highly developed, where much history and tradition is transmitted orally, and where sources of reference are not always immediately available, rote learning may well have a more important part to play in a child's school education.

(Eshiwani 1993: 157)

In his analysis of pedagogy within theological education in Uganda, Slater (2002) concluded that there was a collision between the literacy approach in the theology classes and the primarily oral culture of learning among students and the local community. At the theological colleges he visited there was apparently very little culture of reading. Students appeared to value possession of the text over reading it and libraries were present, but infrequently used. He found that learning through writing was not valued (2002: 214). Both students and teachers commented that indigenous learning patterns were predominantly oral, based on discussion and

---

<sup>12</sup> The adult literacy rate for Tanzania is around 70% and well above the literacy rate for Sub-Saharan Africa (UNESCO 2004).

<sup>13</sup> Even within Dar es Salaam, shops selling non-academic literature are only found in areas largely frequented by the expatriate community.

consensus. Slater suggests that the imposition of literacy-based education on a primarily oral society may encourage transfer rather than reflection upon text (2002: 251).

Folk psychology in recently oral cultures, or in transitional cultures where written information sources are scarce, may tend to see words as very closely related to concepts. There is a tendency for utterances by authority figures or texts to take on sacred worth within the community and to be seen as having high intrinsic value. Within this context there is a much greater value for memorisation in the learning process. In Western information-rich societies, the text and its interpretation are seen as separate, the skills of analysis and selection of appropriate information are valued more than the information itself and this is reflected in pedagogical ideas. Learning is seen as personal construction of meaning.

### **1.5. Tacit Knowledge in Science and its Distribution**

The attachment of concepts to words privileges knowledge that can be codified over knowledge that can only be demonstrated through practice, often referred to as skills. Education systems tend to accentuate the promotion of the codified knowledge by assessing learning through written or oral examination rather than through practice. Science is commonly regarded as a body of knowledge that can be encapsulated and transferred in an entirely codified form. But if we take into account the tacit knowledge involved in science (Polanyi 1967), much of which is uncoded, it can be seen as a craft, with experts having personal knowledge; or as a culture, with the knowledge distributed throughout a community and their tools.

In his empirical studies of practising scientists, Collins (2001) found that detailed written descriptions and diagrams were not always sufficient for one group of scientists to repeat the experiments of another group with the same results. For a scientist to “learn” from another how to perform an experiment it was often necessary to have personal contact with the “expert scientist”. The knowledge exchanged by such interactions is difficult to recognise and is referred to as tacit



knowledge (Polyani 1967). Collins describes five types of tacit knowledge: deliberately concealed knowledge, mismatched salience, unrecognised knowledge, ostensive knowledge, and uncognised knowledge. In the educational context it is rare for knowledge to be deliberately concealed, except for pedagogic reasons when a teacher does not want to confuse their students. However, the role of the other types of tacit knowledge within science education is likely to be highly significant.

With any didactic scientific material, either text, demonstration or diagram, there is an indefinite number of different aspects to focus on. The aspect that a teacher intends to be the focus is not always the same as the aspect that strikes the learner as most significant. This has been shown to occur often in the case of science experiments (Driver 1983). In the case of texts, readers sometimes attribute the same or greater priority to the examples as to the principle being illustrated (Dahlgren 1984). This is what Collins (2001) refers to as mismatched salience. Acts that are so every day that they become almost habitual involve using unrecognised knowledge. When a teacher sees something as trivial or does not recognise it as knowledge they will not mention it to the learner. This becomes problematic when the learner has a knowledge gap in this area. By ostensive knowledge, Collins refers to knowledge that can be transferred through pointing or demonstrating. Science teachers may be limited in their ability to do this by a lack of resources. Polyani refers to definitions that rely on exemplars as 'ostensive definitions' (Polyani 1967: 5).

Uncognised knowledge is knowledge that has never been codified into language or other symbol systems (numbers, diagrams etc.) and therefore goes unrecognised as knowledge. It can include both practical and conceptual knowledge. For example, it would be very difficult if not impossible to describe how to walk in words alone. Similarly, everyday abstract concepts such as "health", "friend" and "work" are not always easy to verbalise with crisp, concise and inclusive definitions. According to Bloch (1998) this uncoded knowledge changes in nature through the act of codification, and some element of it is lost by trying to put it into words.

Science educators and educationalists have stressed the importance of seeing and doing science in lessons over mere listening and reading. However, these activities are often seen as ways of reinforcing the codified knowledge found in textbooks or as ways of providing memorable experiences to link to the “facts” in order to anchor them into the brain. If Collin’s theory of tacit knowledge holds for school science, then the act of seeing and doing does more than simply reinforce the codified knowledge of the textbook, it passes on aspects of scientific knowledge that go beyond what is written.

Tacit knowledge does not only cover the knowledge needed to carry out experiments and practical work. Ways of thinking and solving problems can also involve tacit knowledge. Van Driel, Beijaard and Verloop (2001) refer to this whole body of knowledge about ‘doing science’ as practical knowledge, including activities such as balancing equations, solving problems and interpreting data. Tacit knowledge does not appear on the science syllabus, either because it cannot be written or it is not recognised or seen as important.

Ravetz (1971) describes scientific research as a craft. He argues that it involves a personal, tacit knowledge of the objects to be worked with. Scientists need to have this type of knowledge about their apparatus so that they can know when it is working “properly”. They need to develop a deep understanding of how the equipment works in order to avoid accepting false readings too easily. Further craft knowledge is needed to transform the selected data into meaningful information. Describing science as a craft has huge pedagogical implications. Craft knowledge needs to be passed on directly from master to learner through personal contact. The skills of a master craftsman cannot be dealt with in isolation from the craftsman (Ravetz 1971). Craft is learned through apprenticeship rather than through theory. A second implication of treating science as a craft is that teachers have to be masters with a huge base of tacit knowledge to draw upon. This is especially the case in discovery science where students will often encounter false readings in experiments. The teacher needs an in-depth knowledge of the apparatus in its particularities if they

are to be able to guide the students as to which readings to take or how to adjust their apparatus in order to generate valid data.

If we take science to be the body of knowledge, both explicit and tacit, needed to operate as a scientist, then science fits into Bloch's definition of a culture (Bloch 1998:4, see above). Bloch adds as a footnote that the knowledge around which a culture is based does not need to be known in its entirety by every member of the community, but can be distributed throughout it. Scientific knowledge is distributed throughout the community of scientists and their tools.

For an individual to be able to think and operate as a scientist he/she needs to have access to a community of scientists and to its tools. A scientist cannot "do science" in total isolation, just as a lone Maasai cannot embody Maasai culture if isolated from his/her community and tools. The knowledge (of how to be a scientist or a Maasai) is dependent on the community and tools throughout which it is distributed. If much scientific knowledge is tacit, then a critical mass of "experts" is needed as the tacit knowledge is embodied within them. Without a critical mass of scientists and a minimum level of technology, scientific knowledge may not be sustainable within a society as the main means of transmission will be through text rather than through enculturation. Only the explicit knowledge is passed on and the tacit knowledge gets eroded away with each subsequent transmission from teacher to learner.

While I have argued that the coexistence of supernatural beliefs and scientific knowledge is a global phenomenon, the degree to which conventional science is embedded within culture varies greatly between European and African contexts (Kyle 1999), and crucially, between the science teaching communities within these different contexts. Using the participation metaphor for learning, teachers can be seen as cultural ambassadors, or as ethnographers, passing on the knowledge of scientific culture to the next generation. In a Western context, teachers have a high level of contact with the scientific community through their own education and through the extent to which science is common in every day life. By contrast, Tanzanian teachers may have had very little contact with scientific culture. Under

this situation of cultural isolation, separation between the culture of Tanzanian school science and the culture of Western science is a likely result. Science remains a foreign culture, and, as with all ethnographers studying foreign cultures, there is a tendency to focus on the explicit and the exotic aspects of it, ignoring aspects that may be common with the home culture. So, for example, scientific knowledge embedded in local technology has not been explored or linked to school science by Tanzanian teachers (Knamiller, Osaki and Kuonga 1995).

## **1.6. Conclusions**

Both Kenyatta (1961) and Nyerere (1967) point out key aspects of traditional African education which they felt were lacking in the formal education imported from the West. As mentioned above, both claim that traditional African education was aimed towards maintaining and strengthening the community and that the learning process itself was a communal action. They also stress that learning was done by doing-through imitation and repetition of actions rather than through verbal instruction. A third aspect is that traditional education was seen as relevant whereas colonial education was seen as abstract and not easy to relate to African life.

Nyerere describes how children learned in traditional society.

They learned by living and doing...They learned the kind of grasses which were suitable for which purposes, the work which had to be done on the crops, or the care which had to be given to animals...Through these means, and by the custom of sharing to which young people were taught to conform, the values of the society were transmitted. (Nyerere 1967: 2)

Kenyatta contrasts the situatedness and relevance of African traditional learning with colonial education

...instruction is always applied to an individual concrete situation; behaviour is taught in relation to some particular person. ...whereas European schools in Africa provide training in nature study, woodwork, animal husbandry, etc., much of which is taught by general class instruction, the tribal method is to teach the names of particular plants, the use of different trees, or the management of a particular herd of sheep and goats and cattle. (Kenyatta 1961: 120-121)

Cole (2005), while providing caveats against seeing educational development as a process that takes place along a universal linear axis within different cultures, gives an overview of the development of education from small hunter-gatherer societies through to industrialised societies. The aspects of 'traditional African education' as described above, fit the general pattern that Cole describes for pre-industrial societies. Cole sees the introduction of writing as both a product and a necessity for the development of larger, more complex societies. The introduction of writing necessitates the introduction of schools as places where literacy skills can be learned. Writers tend to agree that pedagogy in schools at the early stages of educational development is authoritarian and focuses on the verbatim memorisation of texts (Beeby 1966; LeVine and White 1986; Cole 2005). As societies become more industrialised, schooling becomes more organised and more focused on education for manpower development. As teachers become better educated and schools better resourced, education focuses more on understanding than on memorisation. As sources of information become more abundant, interpretation and analysis is valued over replication.

In the West, the process of making meaning has for a long time been seen as an individual one and this has been reflected in the pedagogical approaches promoted by educationalists. European educational theory has stressed the need for instruction to be designed around the cognition of the individual learners, with teaching designed to ensure that all students play an active role in classroom activities. Western discourse on the development of education in non-Western contexts has tended to assume that this is an ideal to which all education systems should aspire. However, comparisons of pedagogy and learning outcomes between Eastern and Western contexts imply that more communal, teacher-centred pedagogies are valued in other contexts and can be highly effective, even according to Western criteria such as the TIMSS results.

It appears that Western models of education have started to go full circle, and are now harking back to the benefits of the type of education that took place in pre-industrial societies; regretting the loss of the virtues of apprenticeship learning which



resulted from the institutionalisation of schooling. The metaphor of learning as participation and the loss of faith in the transferability of abstract generic thinking skills call for a return to education where learners become enculturated into adult society through practice rather than through accumulation of abstract knowledge. The focus is on the collective achievement rather than the individual, on knowing how rather than knowing what, and on a curriculum that is situated in the life experiences of the learner rather than on abstract theories. In other words, the emerging Western paradigm promotes all the elements of education that Nyerere and Kenyatta describe as aspects of traditional African education.

Assuming that we accept the hegemony of Western thought in pedagogical development in Africa as an inevitable outcome of globalisation; this shift in pedagogical thinking in the West towards a participation metaphor for learning offers potential for a harmonisation between African culture and Western pedagogy. However, within science education, the practicalities of the participation metaphor remain highly problematic due to the lack of interaction between Tanzanian science teachers and contemporary science. The main conduit of transfer of information between science and schools remains a limited number of texts. There is a danger that secondary school science could remain a culture apart from modern science and apart from learners' everyday lives. This separation is likely to privilege textbook knowledge over practical, tacit knowledge that can only be passed on through personal contact. The community of practice within school science becomes one that functions to preserve a canon of textbook knowledge rather than to develop scientific approaches to understanding the world. Pedagogy in school science in Africa may have the potential to become more learner-centred, cooperative or even to move towards the legitimised peripheral participation model; but if the community of practice into which learners are enculturated is one that operates to its own internal rules, distinct from both modern science and everyday life, to what gain is this pedagogical shift?

Western pedagogical approaches have been developed within a context where sources of knowledge, both codified and tacit, are widely available and readily

accessed by the educational community. The pedagogical culture is dependent on the wider culture of the society and is therefore not easily transposed to different contexts where the culture and the knowledge environment are very different. However, as I shall discuss in the following chapter, the desire to adopt educational practices that are seen as modern often overrides efforts to adapt these practices to the context.



## **2. Education for Adaptation or for Modernity? An historical overview of the pedagogical influences in Tanzania's education system**

The previous chapter discussed possible areas of conflict between Western pedagogies and African indigenous culture. Taking the long view of the history of educational development in Tanzania, terms such as 'indigenous/African', and 'colonial/Western' become problematic. Tanzania has only relatively recently been defined by its current set of borders and has seen successive waves of colonisation and migration by peoples from Africa and elsewhere. Over time, the cultural practices of the incomers have been adopted and indigenised by the local population; hence it is difficult to isolate what is indigenous African from what is Arabic<sup>14</sup> and from what is Western. Ignoring the way that culture changes over time runs the risk of restricting the concept of indigenous/African education to an image frozen in the past and viewing current practices in formal education in Tanzania as if they were a purely Western import. This chapter explores the import and adoption of pedagogical practices through an historical perspective in an attempt to elucidate the influences driving current pedagogical practice.

Throughout the colonial and post-colonial history of education in Tanzania, there has been a tension between the desire for a modern education system modelled on Western ideas and society, and the belief that education should be adapted to the local context, in terms of both content and delivery. The proponents of adapted education have tended to be those who had themselves enjoyed a modern, predominantly Western education. The British Colonial Administration, Nyerere and various donors have attempted to develop an education system adapted to Tanzanian culture and society. However, despite the relative power of these education policy shapers, the popular demand has generally been for a Western-style education system that will prepare the next generation for modern sector jobs. Education policy in practice has tended to reflect the popular choice of education for modernity as

---

<sup>14</sup> By the 12th century, Arabs from the Persian gulf had set up trading posts on the coast of present day Tanganyika. In 1840, the Sultan of Oman set up his capital in Zanzibar and ruled over a loose empire that extended onto the mainland.

modelled by the West rather than official policy that has sought to adapt education to the local context.

Several key dimensions of the adaptation/modernisation debate emerge through this consideration of Tanzania's educational history. The first is structural: should educational development focus on the provision of primary education for all that will equip the majority with the basic skills necessary for rural life or should it focus on providing quality post-primary education and training to develop manpower to fill modern sector jobs? Whilst this issue is not in itself a pedagogical one, the changing funding priorities and the rate of expansion of the school system have determined resource levels, which have had a major influence on pedagogy. The second dimension is curricular: should the curriculum aim to provide 'relevant' and applied skills such as agriculture or 'modern' academic courses such as the pure sciences? Should science syllabi reflect local technology and conditions or should they aim to teach laboratory-based courses to prepare the next generation of research scientists? A third dimension is pedagogy. As discussed in the previous chapter, different cultures have developed different pedagogical approaches; so should pedagogical practice in Tanzania be guided by local practices or by Western models of pedagogy? Another dimension of particular relevance to secondary education in Tanzania relates to the medium of instruction: should education be in a local language or in a Western language that is understood globally?

## **2.1. Pre-Colonial education**

In seeking a model of African education that is uncontaminated by Western influence and encapsulates a truly African pedagogy, one might be tempted to look back to the pre-colonial systems of education. The image one gets of pre-colonial education systems depends on who was writing the history and when. Hopkins (1973:10), describes two distinct images of pre-colonial Africa as "primitive Africa" on one hand, and "merrie Africa" on the other. In the "primitive Africa" accounts, there was either considered to be no education or an education limited to rather brutal and mysterious initiation ceremonies (see e.g. Schwab 1947). The more positive "merrie

Africa” version is found in postcolonial writings such as those of Nyerere (1967), Rodney (1972) and Mbilinyi (1979a). These describe pre-colonial education in terms of its relevance, its strength in nurturing co-operation and equality and its focus on learning by doing. Mbiti (1969) gives both sides of the story, describing some of the painful and frightening experiences that youths in training endured, but explaining how these teaching processes were used to nurture endurance and courage in the trainees.

Whilst most education and child rearing were done informally through extended families, many societies had initiation periods where children and adults nominated to be teachers stayed apart from the community for a set period of time. Mbilinyi (1979a) refers to this as formal schooling. In some societies, such as the Wabena and the Nyakusa of Southern Tanzania, the initiation training process was a highly organised one which could be considered to be formal education (Ocitti 1994). But as Cole (2005) points out, it is only with the introduction of literacy into a society that there comes a need for extended periods of learning within specialised institutions comparable to modern schools. Literacy was introduced by the Arab settlers through Koranic schools (Cameron and Dodd 1970), but this was mainly restricted to the coast. As mentioned in the previous chapter, pedagogy in the lower reaches of Koranic schools involves chanting and rote memorising of the sacred text. Students are taught to read and write in order to be able to transcribe the sacred text, and this was, and still is, done in a foreign language that was not understood by the majority (LeVine and White 1986).

European-style education was first introduced to Tanganyika by missionaries in the mid 19<sup>th</sup> century. In the early mission schools there was little distinction between the educational and evangelical aims of teaching. Schools taught religious instruction, but also taught literacy as this was seen as necessary for studying the scriptures. In most missions the curriculum focused on the three Rs although some mission schools included other academic subjects such as geography. Skills such as carpentry and tailoring were also taught (Thompson 1976). Many of the early missionaries saw the African culture that they encountered as an evil and backward one from which they

needed to rescue people; so little was done to preserve it by adapting the curriculum (Cameron and Dodd 1970: 54). However, mission schools were adapted to local culture in that they taught through the local vernaculars rather than through the trade language of Kiswahili (see section 2.5 below)

## **2.2. Education under European rule**

When the country became a German colony in 1885 the Government set up schools to provide for the manpower needs of the administration (Buchert 1994). The education was in Kiswahili, but there was an explicit intention to spread German culture and to inspire patriotism to the German Kaiser through the education system (Schlunk 1914/1964). It should be noted that in the early days of colonial education, African parents were often reluctant to send their children to schools. The earliest mission schools mainly taught freed slaves and other socially marginalised groups, as those with greater social capital within the local communities did not see the need for schooling. Local chiefs were required to send their sons to school in Tanga where they were trained in clerical skills by German teachers, but local populations remained sceptical over its value (Buchert 1994). However, this scepticism soon changed as Africans began to see schooling as a means of gaining social status through employment within the colonial structures. By the time of the First World War, the indigenous social demand for education was sufficient incentive for Africans to take over the running of schools when many of the missionaries and colonial education officers departed (Cameron and Dodd 1970: 65).

After the First World War, Tanganyika was handed over to the British as a mandated territory under the League of Nations. From the mid 1920s the British education policy in Tanganyika became one of “Education for Adaptation”, based on the recommendations of the Phelps-Stokes commissions to Africa (Jones 1922, Jones 1925). This policy supported a broad-based, relevant education system with the curriculum adapted to the assumed realities of rural African life. The 1925 Colonial

Office memorandum *Educational Policy in British Tropical Africa* summarised the principle of adaptation as follows:

Education should be adapted to the mentality, aptitudes, occupations and traditions of the various peoples, conserving as far as possible all sound and healthy elements in the fabric of their social life.

(in Scanlon 1964: 96)

Sir Donald Cameron, who became the governor in 1925, declared the 1925 memorandum as a charter for education in the protectorate. Up until this point, the mission schools had acted independently of the government and much of the education taking place had been highly catechetical. Under Cameron, mission schools became linked to the government through a grants-in-aid scheme. Education was reorganised into village schools and central schools. Village schools taught in the vernacular<sup>15</sup> or Kiswahili. Agriculture was central to the curriculum and most schools had their own farms. Central schools were mainly staffed by expatriates and taught vocational and industrial courses as well as academic courses in English. These schools were encouraged to develop independently as much of an African character as they could. Hygiene, agriculture and nature study were promoted rather than pure science (Thompson 1968).

One of the few examples of attempts to put the policy of Education for Adaptation into practice wholeheartedly was at Malangali School in Iringa region. Malangali School was established in 1928 by W.B. Mumford. Mumford himself gave a contemporary account of the adapted design of the school (Mumford 1930). Cadogan (2005) gives a more objective and historical account of the early school history, complete with testimonials from former pupils who studied under Mumford. Mumford based the design of the school and the curriculum on research into the customs of the Wahehe and other local tribes. Tribal elders were employed as advisors to the headmaster and to teach students local tradition and history. The uniform was a toga-like sheet, as had been worn by the Wahehe before the First World War. School buildings were constructed from wattle and daub with roofs of

---

<sup>15</sup> There are around 120 different indigenous languages in Tanzania. Whilst Kiswahili has become the *lingua franca*, the knowledge and use of Kiswahili away from coastal areas and trade routes was limited during colonial times.

reeds and mud. Students practised spear throwing and tribal dancing. The curriculum had a strong agricultural emphasis with around half of the time-table devoted to agriculture and cattle/ dairy work. Combined with six hours of tribal instruction this left only twenty hours a week for classroom instruction. Students were taught in Kiswahili and did not learn English.

From Mumford's own accounts, many of these adaptations were popular with the local community and with the students, but Cadogan finds extensive evidence of local resistance. Attendance at the school was compulsory for sons of headmen and for many it was the only post-primary education on offer. Even so, a high proportion of students did not return after their first year. Football proved much more popular than spearthrowing. Cadogan's informants felt that they had been particularly disadvantaged due to the lack of instruction in English, as fluency in English opened up relatively well-paid employment opportunities. Africans had only been consulted about their traditions, but not on the type of education they themselves wanted. Mumford's vision of African life was a static one, and did not take into account the rapid social and economic changes taking place.

The Malangali version of Education for Adaptation was also unpopular with many in the colonial administration. Mumford's work was harshly criticised and seen as a failed experiment by many (see for example Cameron and Dodd 1970: 64). It can be seen as an extreme version of adapted education that went well beyond the vision presented by the Phelps Stokes commission; but it does illustrate potential problems of that vision. The school continues as a secondary school today, but the adapted elements of the school were largely abandoned on Mumford's departure in 1932.

The Phelps-Stokes philosophy of Education for Adaptation was also put into practice in the Jeanes schools in neighbouring Kenya, as described by King (1971). The African Jeanes teacher learned how all school subjects could be Africanised. Arithmetic was taught using village statistics, drama was used in health and agriculture education, local songs and stories were also integrated into the curriculum. The British administration supported the Jeanes schools, but the Kenyans



preferred to attend academic schools rather than adapted ones when the choice was available. Like Malangali school, the Jeanes schools demonstrated that the Phelps-Stokes model of education could not overcome the attractions of the traditional Western curriculum and that village life could not be considered to be isolated from developments in the urban centres where elite, Western-style education led to modern jobs.<sup>16</sup>

The colonial policy of Education for Adaptation could appear to be entirely well intentioned, protecting the Africans from the cultural imperialism of an irrelevant, alien school curriculum. However, European and Asian populations were not considered to need such a paternalistic protection and had their own separate education systems that were allowed to follow academic curricula. This segregated education system had not been the intention of the metropolitan power (Buchert 1994), but the colonial government clearly felt that the education prescribed for the Africans was not suitable for their own children. The segregation of schooling brings the ethical justification of Education for Adaptation into question. It must be conceded that the provision of a curriculum adapted to the local culture is an ethically contentious task. If race is taken as the determinant of culture, then the arguments of adapted education can be used to support racially segregated education, based on the idea that each culture should have its own adapted curriculum. It is almost inevitable that the provision for one race will be superior to that of another, especially when the socio-economic gulf between groups is as great as it was between the Europeans and the Africans in colonial Tanganyika. Hence adapted education can often be, both in appearance and practice, racially discriminatory. In South Africa, the Bantu Education Act used the idea of “appropriate” education to justify inferior education for black Africans and segregation in the education system.<sup>17</sup> However, to provide the same education for all assumes that the education model applied is relevant to all and risks being imperialistic.

---

<sup>16</sup> Whilst the jobs were mainly in the urban centres, it should be noted that many of the elite schools were situated in rural areas.

<sup>17</sup> The Bantu Education Act of 1953 led to schools for Blacks having less qualified teaching staff and higher pupil: teacher ratios than before the act. Bantu education had much greater vocational content than education for Whites (Christie and Collins 1984).

Although the education system under British colonial rule was adapted to local needs, it was the needs as the colonial powers interpreted them (Cameron and Dodd 1970). Murray (1938/1967) criticised the Phelps-Stokes reports for their static image of African life and the assumption that the old way of life would be attractive to Africans. He pointed to the inevitable influence of the interaction with Europeans, what in today's language would be called globalisation, and argues that this influence made Education for Adaptation an unrealisable policy.

This is an educational policy possible only in theory, for it ignores the very community which Dr. Jones<sup>18</sup> would have us remember. The "community" of which the Native is part includes in these days the white man, and the destiny of black as well as white is bound up with this fact. (Murray 1938/1967: 308)

Adapted education tended to be unpopular with the Africans themselves, who generally sought a European-style academic education. Lewis (1948) pointed out that schools in Africa entirely under African administration tended to be more academic than those controlled by Europeans. Ball (1983) argues that the drive for an academic curriculum, similar to that taught in English grammar schools, came mainly from the Africans themselves as an act of resistance to what they saw as a second rate education. His argument is supported by the fact that many newly independent African states turned to their ex-colonial powers for new curricular input and often imported whole educational packages with little attempt to adapt them to the African context (Serpell 1993; Brock-Utne 1995; Semali 1999). In colonial Tanganyika, agriculture and animal husbandry were included in the curriculum on the basis that these were relevant skills for most Africans. However, agriculture courses were unpopular, and practical agriculture was dropped from the primary curriculum at the end of the colonial period, though it would be reintroduced just a few years later by Nyerere (see below.)

British policy gave little attention to secondary education, either in terms of quantity or quality. The priority was mass education, giving a basic education to as many as possible, rather than focusing resources on the higher levels of education. The first school to offer secondary education for Africans was Tabora, which became a

---

<sup>18</sup> Director of the Phelps-Stokes Commissions.

secondary school in 1934 and offered a two-year academic course taught in English. The first school to offer four years' post-primary education was Minaki, and the first cohort sat the Cambridge Overseas school certificate as late as 1947 (Mukyanuzi 1978). In this year the *Ten Year Plan for the Development of African Education* came into operation (Government of Tanganyika 1947). No further expansion of secondary education was envisaged by the plan, although the review in 1950 allowed for a slight increase in enrolments through expanded class sizes (Kamwela 1977). In the last few years of colonial rule, the *Five Year Plan for African Education* (Government of Tanganyika 1956) turned resources to the expansion of secondary education. This led to a proportionately dramatic increase in the number of secondary school places, but there were still only 700 African pupils in form IV at the eve of Independence (Eliufoo 1968).

Ideas of adaptation were not extended to the secondary curriculum as secondary school places were reserved for a select few destined for modern sector jobs, so there was less apparent need for fundamental adaptation of the British school certificate curriculum. Although there was some adaptation to the syllabi for History and Geography, the Cambridge Overseas School Certificate syllabi for the sciences were almost identical to the ones taught in British schools. The few generic alterations for students in tropical areas were confined to alteration of biological specimens to tropical ones. Most of the science questions were abstract or based on laboratory procedures and it was assumed that there was no need to adapt these to the African context. The abstract knowledge of the British science curriculum was considered to be acultural and African schools were expected to have laboratories equivalent to those found in British schools (Wedgwood 2003a).

At the close of the British colonial period, L.J. Lewis, then Head of the Department of Education in Tropical areas at the Institute of Education in London, summarised British Overseas education policy and practice as follows:

A review of British attempts at relating the content and methods of education to local needs suggests that their greatest value lies in the variety of solutions that have been attempted, and in the persistence shown in pursuing this policy rather than in the degree of success attained in specific experiments.

(Lewis 1962: 90)

The relatively limited supply of formal education in Tanganyika in the 1920s meant that it was a good potential test bed for trialling Education for Adaptation. During most of the remainder of the colonial period the authorities promoted education in local languages and a curriculum that included agriculture and hygiene rather than pure sciences, but the demand for 'modern' (i.e. academic, Western style) education could not be easily curtailed. The structure of the education system was also adapted in that, until 1956, primary and mass education had been supported over secondary education by the authorities. But the demand for secondary education was high, as demonstrated by the rapid growth of the system in the first few years after Independence.

### **2.3. After Independence**

Immediately after Independence in 1961, education policy focused on manpower development, as it had in the final years of colonial rule, and secondary education expanded rapidly, with a doubling of secondary enrolment between 1961 and 1966 (Skorov 1966; Buchert 1994; MoEC 2003). Policies focussed on making up for the serious shortfall in well-educated manpower to take up posts vacated by the departing British. Education was seen as a tool for bringing about rapid modernisation. The curriculum was academic with science and technology strongly promoted. Due to the very limited post-primary education available prior to Independence there were very few Tanzanians with the qualifications necessary to teach at secondary level. Large numbers of expatriates were employed through schemes such as the *Teachers for East Africa* programme. They worked on short-term contracts as they were seen as a stop-gap measure to provide education while more Tanzanian teachers were trained (Wedgwood 2003a). Many volunteers from the UK and America went to teach in Tanzania through the Voluntary Services Overseas (VSO) and Peace Corps. In 1968 there were 131 VSO volunteers in Tanzania and most of these were graduates working as volunteer teachers, although VSO also sent school leavers out to teach (Bird 1998).



The 1960s could be seen as somewhat of a “golden age” of science education in Tanzania. Whilst the scale was still small, quality was relatively high. In 1964, for example, pass rates for the separate sciences were all above 70%.<sup>19</sup> Schools had functioning laboratories and, where modern equipment was unavailable, schools improvised with their own alternatives (Wedgwood 2003a). The vast majority (around 80%) of secondary school teachers were graduates, although the size of the cadre as a whole was small. However, most of these graduates were expatriates.<sup>20</sup> The nascent higher education system<sup>21</sup> was unable to produce African graduates at a rate to match the expansion of the secondary education system; so as the expatriate teachers were replaced by Tanzanians through a concerted programme of Africanisation, the percentage of graduates fell (Pratt 1969).

Developments in science and mathematics education in the West in the early 1960s sparked off a number of curriculum projects in East Africa. These included the USAID funded African Primary Science Project (Dyasi 1976; Savage 1998) and School Mathematics for East Africa, which was an adaptation of the British School Mathematics project (Lillis 1985). Nuffield Science was taken as the basis of the East Africa School Science Project (SSP). The momentum behind the SSP curriculum development came mainly from teachers from British grammar and independent schools who had been recruited to work in East Africa. They brought with them the ideas about discovery learning that were becoming popular at that time in British schools (Lillis and Lowe 1987; Wedgwood 2003a). Certification of secondary education remained under the control of Cambridge, but syllabi and textbooks were designed by teams of teachers. This enabled teachers to adapt the syllabus content to the local context. However, these curriculum development teams were dominated by expatriate teachers; so it is difficult to describe their output as truly ‘local’. Whilst content was localised; for example, by the inclusion of class

---

<sup>19</sup> In comparison, pass rates in 1995 for the separate sciences were all under 60%. Only 31.5% of candidates passed biology (Malekela 2000).

<sup>20</sup> For example, in 1965, Pratt (1969) reports that there were 1064 secondary school teachers. Of these, 839 were graduates (79%) but only 65 were Tanzanian graduates. Most of the Tanzanian teachers (217) were not graduates.

<sup>21</sup> There was no higher education in Tanganyika prior to Independence. The University of Dar es Salaam (UDSM) was established in 1961 as a college of the University of London and it became a college of the University of East Africa 1963. It did not become an independent university until 1970 (Cooksey, Levey and Mkunde 2001).

readers on the indigenous iron making and brewing industries, there was an assumption that the pedagogical approach developed in the West would be transferable to African schools. The implementation had some degree of success in well-equipped schools with graduate expatriate teaching forces, but it was not sustainable as the system expanded and schools became less well resourced.

Throughout the 1960s, the use of the Cambridge Certificate of Secondary Education was a dominant influence on the curriculum and pedagogy in secondary schools and arguably had a backwash effect on the curriculum and pedagogy in primary schools. As had been the case in the 1950s, the questions on the pure science papers included very few applications to everyday life and most of the questions would have been as abstract to a British student as they were to a Tanzanian one. The general science paper was more applied and, as a result, was more context specific. The 1962 paper, for example, contained references to “frosted glass”, “a trombone player”, “faulty electric plugs” and several other items that Tanzanian pupils would not have been familiar with (Wedgwood 2003a). Agricultural science, a subject that had been seen as key to adapted education, was available at secondary level, but it remained very unpopular.

In the 1960s the mood among international and bilateral development agencies was more one of modernisation than of adaptation and Africa was seen to be moving towards the Western model of modern life. Science education was seen as a key investment by international development agencies and national governments (King 1991). There was little thought given to how appropriate the pedagogy was. It was felt that Africa should not be given second best, but have the same type of education as in the West. This spirit of equivalency orientation was a product of the age of optimism in the potential of science for solving development problems and a sense of universalism. SSP was typical of this spirit. Whilst local examples were used to illustrate the science, the Nuffield approach on which it was based focused on training students as future scientists and was high in academic content.



In 1967 Education policy in Tanzania was dramatically reoriented according to *Education for Self-Reliance* (ESR) (Nyerere 1967). In ESR, Nyerere presented a bottom-up model of development based on a predominantly rural economy and a socialist ideology.

...the truth is that our United Republic is at present a poor, undeveloped, and agricultural economy. We have very little capital to invest in big factories or modern machines;...What we do have is land in abundance and people who are willing to work hard for their own improvement.  
(Nyerere 1967: 7)

This turned the tables on modernisation development models of the World Bank and other international organisations at that time. Modernisation favoured investment in secondary and higher education for manpower development (Heyneman 2003; Samoff and Carrol 2003).

Nyerere argued that the developing education system was elitist in that it was designed to meet the needs of the minority who gained access to post-primary education. This was inequitable as government spending was funding the education of a small elite rather than education for the masses. He argued that the country could not afford 'education for education's sake', and that it was wasteful to have a primary curriculum that was devoted to preparing students for secondary education to which only a small minority had access. ESR returned the focus of educational development to the provision of basic, relevant education for all. The primary curriculum was to be reoriented to provide school leavers with the skills necessary self-reliance in a rural economy. Agricultural activities became a central part of school life at secondary as well as at primary. Secondary enrolments continued to grow, but the expansion was controlled according to national manpower requirement forecasts. The Education Act of 1969 nationalised all non-governmental run schools (Mbilinyi 1979b) with the exception of seminaries which were permitted to continue under church control on the rationale that they were specifically for training up potential priests.<sup>22</sup>

---

<sup>22</sup> Many graduates of seminaries did not enter the priesthood. The seminaries provided a higher quality alternative to the state education system for strategic parents. Seminaries tend to occupy most of the top places when schools are ranked by examination performance.

At the end of the 1960s most of the British educators left Tanzania due to a diplomatic dispute over the payment of expatriate pensions (Bird 1998: 57). The Peace Corps were also requested to leave due to disagreements over the Vietnam war and Education for Self-Reliance. In the early 1970s Tanzania developed its own exam board and wrote its own curriculum. This was a combination of the new Nuffield ideas with the old school certificate (Van Praagh 1988). The result was a syllabus containing both the highly abstract concepts of Nuffield science and the heavy fact base of the traditional syllabus. The Nuffield pedagogical approach, as presented through SSP, was not sustainable in the growing education system with its ever more limited resources and less qualified teaching force (Osaki 2000). The abstract concepts, crowded by other content and divorced from the discovery approach pedagogy of SSP, just became yet more facts to learn.

Africanisation of the education system throughout the 1960s and 1970s through replacement of foreign staff, school management, curricula and the examination system apparently did little to ameliorate what Nyerere saw as the ills of the colonial education system, namely its irrelevance, its rejection of local knowledge and examination domination. Mbilinyi describes the situation of secondary education in the 1970s (Mbilinyi 1979b) as one that was, if anything, more authoritarian and based on rote-learning than the late colonial system. Corporal punishment had enjoyed a renaissance in schools. The curriculum was heavily loaded and teaching was almost entirely through the copying of notes in order to memorise them for examinations that tested recall rather than problem solving and creativity. Mbilinyi describes the predominant pedagogies as follows:

One very common teaching method is the 'copy-copy' one: the teacher copies notes or words from a text book or notebook on the blackboard; students copy these notes into their own notebooks; on school tests and Form IV examinations they 'copy' these notes on the paper from their memories. Another common method combines lecture, copy-copy and question-answer. The teacher revises notes from the previous lesson in a ten minute question and answer session, in order to ascertain how much has been remembered. Then he gives a fifteen-minute verbal presentation. Students do not pay very much attention at this stage. But when the teacher puts notes based on his

lecture on the board for another fifteen minutes, he has the students' complete attention as they fill their notebooks.  
(Mbilinyi, 1979b: 106-107)

In 1972 the secondary curriculum was diversified and schools took on either an agricultural, technical, commercial or home economics bias (Omari 1994). This move was in line with Nyerere's vision of ESR, which linked education with production and encouraged schools to raise their own funds through farms or other projects. It was also strongly supported by the World Bank which promoted the development of diversified secondary education at this time (Psacharopoulos and Loxley 1985; Heyneman 2003).

Educational development during the 1970s was dominated by quantitative expansion of primary and adult education that left few resources available for investment in secondary education or for curriculum development. There were therefore few resources available for indigenisation of curricula. The Musoma Resolution of 1974 set the goal of achieving Universal Primary Education (UPE) by 1978 (Carr-Hill 1984). Implementation of this resolution involved an enormous effort to train new teachers and build new schools. Primary enrolment soared from 1.2 million in 1974 to 3.5 million in 1981, whilst secondary enrolments stagnated (MoEC 2004a). Many writers (e.g. Leshabari 2000; Osaki 2000; Rajabu 2000) identify this push for UPE as the cause for the deterioration in quality at all levels of education in Tanzania.

The world economic recession of the 1980s and Structural Adjustment Policies (SAPs) imposed by the International Monetary Fund (IMF) compounded the decline in quality of the Tanzanian education system as it meant that there was no money to correct the "temporary" measures of the push for UPE such as wattle and daub classrooms, and teachers recruited without secondary school education (Mählck and Temu 1989). In the late 1970s educational spending was well above 5% of the gross domestic product, but fell to just 2% in 1988 (Buchert 1994: 104,148). The dream of *Education for Self-Reliance* had failed to materialise and the enthusiasm for UPE soon began to die as the expanded primary cohorts reached the end of primary schooling only to find that the vast majority could not progress to secondary school (King 1984). Transition rates into state secondary schools fell from 7.1% in 1974 to

1.6% in 1984. This reduced the incentive for parents to enrol their children in primary schools and absolute primary enrolments fell from 1983 to 1986. Although total enrolments rose slowly thereafter, the rise did not keep up with population growth and the net enrolment rate continued to fall (MoEC 2004a).

In 1984 the Ministry of Education published the findings and recommendations of the Presidential Commission on Education, frequently referred to as the Makwetta Report (URoT 1984). This report put great emphasis on science and technology and the need for expansion of secondary education. Science and technology were the only subjects to be specifically named in the listing of the aims of both primary and secondary education. One of the aims of secondary education was given as "to provide students with knowledge, skills, principles of science and technology in order to enable them to conduct scientific investigations and to become creative inventors" (URoT 1984: 4). This call to develop science showed a continuing faith in the link between science education and the capacity for development. Mosha is very critical of the way that science and technology was taught at this time and argues that the colonial adapted curriculum, which stressed the application of science to agriculture, construction and homecraft, did much more to inculcate scientific skills than the post-Independence education system (Mosha 1990). More applied subjects were available in schools as part of the diversified curriculum, but they were expensive to deliver and were often not as popular as the pure sciences (Psacharopoulos and Loxley 1985).

Following the Makwetta report, secondary enrolments increased and the share of expenditure on secondary increased (Buchert 1994: 147-149). However, with the overall spending on education stripped to the bone and with an ever-increasing number of secondary schools over which to spread resources, the change in focus of the education policy did little to avert the decline in quality of secondary science education. One outcome of the SAP was that secondary education was opened up to the non-state sector which led to a rapid increase in the number of private<sup>23</sup> schools.

---

<sup>23</sup> Here 'private' refers to non-state and includes schools run by faith based organisations (including seminaries) and community based organisations. The growth of non-state schools in Tanzania is discussed in Lassibille, Tan and Sumra (2001).

The number of private schools soon overtook the number of public ones. By 1990 there were 213 private schools compared with 135 public ones and the majority of form I enrolments were in private schools (MoEC 1991). Generally these private schools were less efficient than government run schools and the expansion of the private sector exacerbated teacher shortages within the education sector as a whole (Lassibille, Tan and Sumra 2001).

The 1980s through to the mid 1990s was a period of decline throughout the whole Tanzanian education system. Primary enrolment ratios decreased and schools fell into disrepair (Kuleana 1999; Wedgwood 2005). In 1995 primary teachers' salaries, in terms of purchasing power, had fallen to 22% of the 1977 level. Secondary teachers' salaries had fallen even further (Kuleana 1999). Motivation among teachers became very low as the salary no longer constituted a living wage (Mosha 2000: 9). This led to many teachers taking on second jobs, and to a flourishing private tuition market (Sambo 2001). Another casualty was curriculum development. The syllabi for the separate sciences remained unchanged from 1976 until 1997 (MoEC 1996a,b,c). O' level candidates had been required to sit a practical examination for sciences, but "alternative to practical" examination papers (see chapter five) were introduced in 1992 due to a shortage of equipment and chemicals (Nkunya 2001; Kibga 2003).

As indicated by the earlier support for the diversified curriculum, the influence of the World Bank and bilateral donors went far beyond structural adjustment and financing and had implications on curriculum and pedagogy. Economic recession left Tanzania highly donor dependent and donor policies have been a major influence on the education system throughout its recent history. Samoff and Carrol have described the donor community as "a small animal with a large roar" (2003: 5) as the influence it has on educational development tends to be disproportionate to its contribution to the overall education budget. In the mid 1990s the donor share of educational spending was just 6% of the total government spending on education. But since the vast majority of Government spending (and none of the donor spending) was used to cover recurrent costs, donor money constituted 78% of the total *development*



expenditure (World Bank 1999b). Donors therefore had a great deal of leverage over the direction of educational change. There was a tendency throughout the 1980s and 1990s for donors to act as innovators, funding pilot projects that the national government was expected to take to scale at the end of the funding cycle (King 1991). These projects came with Western consultants to manage them. In the late 1990s there were over 50 Western consultants working within the Ministry of Education and Culture (MoEC)<sup>24</sup> and, in the absence of strong local leadership, they had a high degree of control (Holtom 2003).

One area where the influence of donors can be clearly seen is that of curriculum development. A feature of the 1980s and early 1990s was the encouragement by certain donors for the adoption of cheap, 'appropriate' alternatives to traditional laboratory equipment in science education (see for example Musar 1993). There was also a global movement to make science education more accessible to all. ZimSci, a low-budget curriculum package used in Zimbabwe, was developed in response to both these trends. It provided low cost science kits and aimed to make practical science available to all children (Ware 1992). The World Bank was very impressed by ZimSci and encouraged other countries to adopt it as a model. But when a delegation from Tanzania went to investigate it they rejected it on the basis that the materials were "too simple" for Tanzanian students (Hongoke 1997: 163).

In 1993 Tanzania introduced Unified Science in trial schools as a cheaper and more accessible alternative to the separate sciences. This was funded by the World Bank, Swedish and Norwegian aid. However, it was very unpopular with parents and students for being too shallow and was abandoned after only three years (Hongoke 1993). Another project that aimed to make science education cheaper and more accessible was the Mzumbe Book Project. This produced books such as *Enjoy Chemistry* (McGuire, Nkunya, and Mihigo 1994), which provided instructions for carrying out experiments using every day objects. The project produced teachers' guides and students' books that were locally published and available at a relatively low cost. It was supported by a Canadian organisation, CODE and a German one,

---

<sup>24</sup> Shortly after the completion of the fieldwork, in December 2005, the Ministry of Education and Culture became the Ministry of Education and Vocational Training.



Aktion Partnerschaft Dritte Welt (APDW). Many of the science books were written with extensive expatriate support.

Almost all curriculum development taking place during the 1990s was under donor funded projects and reliant on donor funds. These developments focused on the priorities of the donors and the international development agencies (environmental education, HIV/AIDS education and family life education), rather than on national priorities. Such programmes were ubiquitous throughout countries in Africa where there was a high degree of donor involvement (Brock-Utne 2000: 127-128). Pressure from donors in the early 1990s, notably the World Bank and SIDA/Sida to privatise and liberalise the textbook market reduced the level of local control in curriculum development and opened the way for pedagogical import through textbook content (Brock-Utne 2000: 76-86).

In the early 1990s donor assistance to education was almost entirely through the project approach. For example, the entire educational assistance spending of the UK in Tanzania was devoted to improving English at secondary schools through the English Language Teaching Support Project (ELTSP). ELTSP funding ended in 1996. At the end of the 1990s, British overseas aid, like that of many countries, was reoriented towards poverty reduction and ELTSP was deemed to have had no poverty reducing benefits (Department for International Development 1999). The case of ELTSP illustrates how educational development in Tanzania was strongly steered by projects run on overseas aid and hence very vulnerable to changes in funding priorities among donor countries. The ELTSP had little impact on students' language proficiency (Roy-Campbell and Qorro 1997), but strengthened the policy of using the English medium at secondary schools, a policy that has had very negative implications for overall quality of learning (Qorro 2003 and see below).

German donors were involved in projects aimed at improving science education in secondary schools. The German Development Bank, KfW, has funded *Education I* since 1994 through the Christian Social Services Commission (KfW 2002). The project supported the development of science education in church run secondary

schools. The project promoted the 'Starter Experiment Approach' to science teaching. This approach is based on discovery learning through practical investigations designed by the students. The teacher carries out a simple demonstration and students are encouraged to make observations and to come up with possible explanations. The teacher then helps students to generate testable hypotheses from these explanations and students design and conduct experiments to test them. Brainstorming and feedback are used to develop the key concepts to be taught. This approach was later adopted and promoted in government schools through the *Education II* project, funded by the African Development Bank (MoEC 2001; MoEC and UDSM 2005).

GTZ, the main technical cooperation of the German Ministry of Development, supported the Science Education for Secondary Schools (SESS) project which started in 1997. This project promoted the use of science textbooks and practical work in government schools in selected regions. In-service training was provided through a cascade model with German education experts providing the highest level of training. A key thrust to all of these projects in science education has been to increase the amount of practical work in science. As noted in the previous chapter, discovery learning approaches to science education with a high degree of practical experimentation by pupils do not appear to be a necessary condition for indigenous technological development and may not be a universal ideal that all education systems should aim for. There is a danger that Western projects may be promoting very expensive options for science education that have not been proven internationally to give the best results, either in terms of student performance in tests or in terms of national development outcomes.

Another major pedagogical influence introduced in the 1990s was the concept of 'participatory teaching methodology' which drew on education projects funded by Sweden and Finland and on discourse from the development community as a whole. The development of participatory teaching methodology is discussed in more detail below.

Since the 1990s there have been two fundamental changes in the influence of foreign aid on Tanzanian educational development. Firstly, aid has become increasingly linked to poverty reduction. Development agencies have become disillusioned with the top down approach to development as the belief that the benefits from high tech projects can diffuse throughout the population was not supported by the evidence of many 'failed' projects of the 1960s and 1970s. Concerns have been raised that investment in post-primary education tends to favour the richer end of society. Development is increasingly seen as being linked to the well being of the population as a whole rather than in narrow terms of economic growth. Towards the end of the millennium, provision of basic needs rather than advanced manpower training and technology came to be seen as the main route to development. The Education for All (EFA) movement, launched at a conference in 1990 (WCEFA 1990), called for Universal Primary Education (UPE). In 2000, donors committed themselves to a set of Millennium Development Goals (MDGs) aimed at reducing poverty. UPE, seen as a human right and as a means for long-term poverty reduction, is one of the MDGs. Donor policy within education has focused increasingly on achieving UPE and many donors have reduced their commitment to post-primary education. The focus of ongoing projects reflects the shift towards the MDGs. SESS now focuses specifically on HIV/AIDS education and girls' science education rather than secondary science education *per se*.<sup>25</sup>

Secondly, the modalities through which bilateral and multilateral development agencies give their assistance are moving away from project implementation and towards Sector Wide Approaches and Direct Budgetary Support (UNESCO 2004). In many cases donors have attempted to harmonise their contributions by pooling money in a basket fund for a particular sector or sub-sector. Theoretically this should mean that educational development, especially at the level of curriculum and pedagogy, should be under greater local control. In practice the leverage is now arguably greater than it was through the project mode. Donors now contribute to

---

<sup>25</sup> In a reaction to this focus on primary education, there have been growing calls for more balance in spending across the education sub-sectors, with donor policy documents once again advocating support of secondary (World Bank 2005) and higher education (World Bank 2002; Commission for Africa 2005).

recurrent costs and so are more involved in the education system as a whole rather than having their influence confined to separate projects. Decisions made at a central level, where donor representatives now have considerable voice, can have implications at the classroom level, such as decisions over the duration and mode of teacher training programmes. Donor support to education in Tanzania is now done largely through basket funding, with donors pooling their funds into one account that goes towards both recurrent and development costs. The pooled basket funding since 2002 has been targeted at the primary sub-sector. The support has become proportionately much more significant. For example, in the financial year of 2002/2003 foreign support to education was 219 billion Tanzanian shillings (TSh) out of a total of around 520 billion TSh, constituting over 40% of spending on education (URoT MoF 2003).

As a result of donor pressure, Tanzania's first Poverty Reduction Strategy Paper (URoT 2000) included the decision to drop primary school user fees (Holtom 2005). This led to a 27% increase in standard I enrolments in 2001. This was followed by the initiation of the Primary Education Development Programme (PEDP) in 2002. Standard I enrolment rates increased by a further 43% in 2002 (MoEC 2004a). The main quantitative aim of PEDP was to achieve UPE by 2005. Qualitatively, it aimed at reducing teacher pupil ratios to 40:1, providing teachers with in-service training and providing a 10 US\$ grant per student to be spent on teaching-learning materials, including one textbook per three students in each subject. PEDP is a national programme, but there is a large degree of donor input, both in terms of the financing and design (Holtom 2003; Wedgwood 2005).

The recent push for UPE in Tanzania has been quantitatively highly successful with total primary enrolments increasing by 72 % (from 4.4 million to 7.5 million) between 2000 and 2005 (Mungai 2005). However there has not been a concomitant increase in the number of teachers; so that the pupil/teacher ratio in 2004 was 1:57, compared with 1:41 in 2000 (MoEC 2004a). In some areas class sizes grew to over 100 and schools have had to introduce shift systems (Mushi, Penny et al. 2003). In 2004 40% of these teachers were "underqualified" meaning that they have not

successfully completed four years of secondary schooling (MoEC 2004a). It is still not clear whether quality can be improved at the same time as increasing quantity. How the expansion of primary schooling will influence the secondary sector which is still suffering the repercussions of the last push for UPE, is yet to be seen, but as Leshabari points out (2000: 139), in the past, the qualitatively detrimental effects of expansion of the secondary sector have tended to be compounded by falls in quality in the primary sector.

Whilst the international pressure around the turn of the millennium has been for expansion of primary education, there has been a considerable national drive to expand the secondary education system. A goal was set in the *National Poverty Eradication Strategy* (URoT 1998) to have a public secondary school in every ward<sup>26</sup> by 2010. Communities have given time and funds to build state run secondary schools and the public sector overtook the private sector in terms of enrolment in 1997. By 1999 there were 444 public and 382 private schools (MoEC 2004a). Since the turn of the millennium, the public secondary sector continued to expand rapidly despite the emphasis by most international donor bodies on UPE. In July 2004 the Minister for Education and Culture, Joseph Mungai, announced the launch of the Secondary Education Development Programme (SEDP) (Mungai 2004). The World Bank is providing 150 million US\$ for SEDP, mainly as a loan, but partly as a grant. In 2005 it remained the only development partner to have committed itself to supporting the project, with the other partners remaining focused on primary education. The Bank has had considerable influence in the design of the programme. One aspect in which their influence can be seen is the removal of the “biases” from the curriculum, which used to include agriculture, commerce, domestic science and technology. Based on evidence from the early years of diversified schooling in Tanzania and Columbia (Psacharopoulos and Loxley 1985), the World Bank has maintained for a long time that diversified secondary schooling is inefficient (Bennell and Segerstrom 1998).

---

<sup>26</sup> A ward is an administrative subdivision of a district. There are around 2500 wards in Tanzania. When the target was set there were fewer than 800 schools, around half of which were private (MoEC 2004a).



There are greater parallels between the 1970s UPE expansion and SEDP than with PEDP. Even though the rate of expansion of the primary education system through PEDP has been dramatic, in proportional terms it has still been lower than the rate of expansion under the previous UPE drive which led to almost a tripling of primary enrolments between 1974 and 1980. PEDP will nearly double the number of primary pupils over a similar length of time (2000-2006). SEDP, even if it follows the medium growth trajectory, will lead to almost a tripling of the number of form I-IV students over 6 years (2004-2010). If the high growth trajectory, as favoured by the government, is followed, the number of lower secondary students will increase by a factor of five over the same period.<sup>27</sup> In the first year of SEDP the total number of secondary school students almost doubled (from 266,896 to 524,325) and over 800 new schools were built (Mungai 2005). Another element of SEDP that is reminiscent of UPE policies is the “crash programme” for training “licensed teachers”. These are form VI leavers who have been given a few weeks training and sent to teach in schools. 615 teachers entered schools in the first year of SEDP (Osaki 2004). Given that the majority of form VI leavers getting division II and above will have found places at universities, these “licensed teachers” are likely to have fairly low A’ level grades. In the Ministry of Education and Culture’s plan for SEDP (MoEC 2004b) it is proposed that the training of licensee teachers will become the main source of new teachers, with over 30,000 licensee teachers entering schools by 2010. This represents almost half the proposed total teaching force. It seems unlikely that these licensee teachers will receive much professional support if they constitute such a large proportion of the total number of teachers.

The international support for PEDP is in line with the bottom-up gradualist approach to development, as envisaged by Education for Adaptation and Education for Self-Reliance. There is a danger that the gains of PEDP will be as short-lived as the previous UPE drive. But the donors have pressed for investments in quality, and with their financial support the qualitative interventions, such as textbook provision and in-service training, are beginning to reach schools. The resource shortages that

---

<sup>27</sup> Under UPE enrolments rose from 1,228,886 in 1974 to 3,361,198 in 1980. Under PEDP they are projected to increase from 4,875,764 students in 2000 to 8,166,608 in 2006. Enrolment at secondary (I-IV) for 2004 is 379,534, the projected enrolment for 2010 is 1,028,88 (medium growth) or 1,912,425 (high growth). All figures from MoEC (2003) and World Bank (2004).



resulted from the expansion of primary education in the 1970s and economic recession in the 1980s had long-term implications for pedagogic culture as schools operated with few texts books and few teachers with education beyond primary level. The pedagogy of the 'Dame School' of Beeby's model was predominant. With PEDP, extra funding should avert this situation. Teacher training programmes restructured under PEDP have promoted participatory teaching methodology and may steer the direction of pedagogical change (see below).

The pressure to expand the secondary education system has come more from national aspirations than from international targets. The rationale given for SEDP highlights the need for a labour force with secondary education in a modern economy that is competitive in a globalised world (MoEC 2004b). The expansion is driven by the desire for modernisation rather than for grassroots development. As mentioned above, SEDP has less international support than PEDP and the proportionate rate of expansion is much greater. This is likely to have similar implications for pedagogic culture as the first UPE drive. These implications are discussed further in chapter six.

## **2.4. Participatory teaching methodology**

Since my earlier experience in Tanzania (ending 2001), the term "participatory teaching methodology", or "*njia shirikishi*"<sup>28</sup>, had become widespread in educational discourse. It was found extensively in teacher education curriculum materials and was often heard in conversations amongst education professionals. The term "participatory" appears to have been drawn from the field of development studies rather than the mainstream educational literature. In the development studies context, it refers to a range of methodologies used in rural research, appraisal and community development workshop facilitation techniques such as Participatory Poverty Assessment (Narayan 1997), Participatory Rural Appraisal (Chambers 1984) and Participatory Learning in Action (Chambers 1997). The term is also used to refer to a

---

<sup>28</sup> "*Njia*" means "way". The term "*mbinu*", meaning "method", is also often used in this context. "*Shirikishi*" is derived from the verb "*kushikiri*", meaning "to act together" or "to co-operate". "*Shirikishi*" comes from the causative form of the verb, i.e. "to cause to act together". The exact meaning of "*shirikishi*" is therefore closer to "co-operative" than "participatory", but where the English is used the term participatory is generally given.

range of techniques used in adult literacy programmes such as ActionAid's REFLECT programme (Archer and Cottingham 1996).

Conversations and experiences within the education departments of two British universities indicated that the term "participatory teaching" is not commonly used within the mainstream educational discourse relating to pedagogy in Western schools. A web based literature search of the term using Educational Research Abstracts (ERA) Online Database and Education Resources Information Centre (ERIC) confirmed this.<sup>29</sup> However; it is sometimes used in the context of education and international development. For example, it was used in the World Conference on Education for All:

Active and participatory approaches are particularly valuable in assuring learning acquisition and allowing learners to reach their fullest potential. (World Conference on Education for All 1990: article 4)

And ten years later in the World Education Forum in Dakar:

Teachers must be able to understand diversity in learning styles and in the physical and intellectual development of students, and to create stimulating, participatory learning environments. (World Education Forum 2000: §70)

And in the 1999 World Bank Education Sector Strategy

Since active learning is generally superior to learning by rote, countries that move strongly toward more participatory and individualized modes of learning will be at an advantage relative to those where teachers talk and write and students listen and read. (World Bank 1999a: 8)

The term has also been applied to mainstream educational activities in other East African countries with a high donor presence, for example, in 2004 the Malawi Institute of Education published *Participatory Teaching and Learning: a guide to methods and techniques* (Malawi Institute of Education 2004). This was funded by USAID and supported by Save the Children.

In Tanzania the term has been adopted by the mainstream educational establishment, notably the Ministry of Education and Culture (MoEC) and the Tanzania Institute of

---

<sup>29</sup> The ERA search of "participatory teaching" gave one hit, referring to health education in Kenya. ERIC gave 13 hits, and only 6 since 1995.

Education (TIE). TIE is responsible for the primary, secondary and teacher training curricula and the inclusion of the term in the teacher-training curriculum has facilitated its rapid spread throughout the teaching community. The concept of “participatory methodology” in Tanzanian formal education has been influenced by European pedagogical discourse and the term has come to encompass ideas about learner-centred education and co-operative learning methods. It is conceptualised as a recent and global revolution in teaching methodology. According to the Ministry guidelines on teaching using participatory methodology:

*...sasa kuna mageuzi makubwa kuhusu njia na mbinu za kufundishia katika nchi zote duniani (MoEC 2004c: 50)*

[ ...now there is a major change in the ways and methods of teaching in all the countries in the world]

Two of the key influences identified by informants in this study have been the Tutor Education Programme (TEP), supported by the Swedish aid agency, Sida, and the Teachers’ Education Project in Tanzania (TEPT), which provides degree and masters level education courses by distance education through Åbo Akademi in Finland. TEP started in 1997 and TEPT started in 1995. Both projects were ongoing during the fieldwork in 2005. There have also been further workshops for education professionals facilitated by academics from Finland. The term ‘participatory methodology’ does not appear extensively in the training materials that the Swedish and Finnish facilitated courses have drawn on. However, many tutors who have passed through the training identified these courses as the source of the concept of “participatory methodology”. Some tutors distinguished between “participatory” methodology as a general approach to teaching in which students take an active role in class and “co-operative teaching and learning approaches” as a specific set of methods that encourage student-student and student-teacher co-operation. The Kiswahili term “*njia shirikishi*” is used for both terms.

The TEP has run out of Morogoro Teacher Training College (TTC) since 1997. In 1998 ten tutors were selected and trained as facilitators. The training and accreditation for the course was provided by Stockholm Institute of Education (SIE). The Tanzanian facilitators then ran a series of training courses for other tutors. By

2000 around 30% of all tutors in Tanzania had passed through this course. Since 2003 the course has changed to a semi-distance mode of delivery and is operated out of four separate TTCs (Lindhe, Malmberg and Temu 2005). Enea Mhando, one of the original facilitators, describes the spread of ideas from the TEP as follows:

TEP pioneered the introduction of participatory teaching strategies and co-operative learning. Philosophically they started with constructivist theories as a means to explain the shift of thinking. The programme brought a wind of change in the teachers' colleges and this swept across the country in bringing about a change of paradigm. This marked a shift of emphasis from teaching to learning.

(Mhando 2006: 9)

The readings for the TEP course are drawn from a variety of sources and cover a wide range of models of teaching and learning. As Mhando notes, the ideas of TEP are based on a constructivist model of learning. The course materials promote the idea of learner-centred teaching as teaching that enables learners to construct their own meaning from the prior knowledge that they bring to the classroom. The role of out-of-school learning in influencing classroom learning is stressed. Co-operative learning methods (Sharan 1994) have been promoted both through the TEP and the Finnish facilitated workshops (Sahlberg<sup>30</sup>, personal communication).

These ideas, mainly deriving from Europe, have been used to construct the Tanzanian concept of *njia shirikishi*. The key elements of this approach to teaching and learning, according to an in-service training pamphlet produced by the Ministry of Education and Culture (MoEC 2004c) can be outlined as follows:

- The teacher is not the sole source of information for the student
- Children learn by doing a variety of different activities
- Children like to learn by working together and helping each other

The pamphlet goes on to stress that to teach is to facilitate learning ("*kufundisha ni kuwezesha kujifunza*") (MoEC 2004c: 11) and describes the teaching process as one of linking out-of-school, experiential learning with knowledge learned in schools:

---

<sup>30</sup> Dr Pasi Sahlberg, an education expert from Finland, facilitated the training. At the time of communication (11/08/05) he was working as a senior education specialist at the World Bank.

*..wanafunzi huenda shuleni tayari wakiwa na ujzi, maarifa na stadi ambazo wanazipata kutokana na mazingira na maisha yao ya kila siku. ...Shule na mwalimu wanakuwa na wajibu wa kuwa kiungo kikuu katika tendo la wanafunzi kujenga maana ya kile wachoijifunza shuleni kwa kukihusisha na maisha yao nje ya shule*

[...students going to school already have experience, knowledge and skills from the environment and their everyday life...The responsibility of the school and the teacher is to be the main linkage for the students in their act of constructing the meaning of that which they learn in school by integrating it with their life outside school.]

(MoEC 2004c: 11)

Participatory teaching methodology is a pedagogical approach that has developed in Tanzania, but has drawn on discourse and practices within the international development community and pedagogical theory and practice developed in Western schools and universities. It is seen as a modern and globally applicable pedagogy. The way it is interpreted and implemented by teachers is discussed in chapters four and five.

## **2.5. Choice of medium of instruction**

The ongoing debate over which language should be used as the medium of instruction in schools also provides a clear illustration of the tension between pressures for adaptation and pressures for Westernisation. In the early days of colonial rule, when there was virtually no post-primary education, the debate mainly centred on the choice between Kiswahili and the local vernaculars. The missionaries supported the use of the vernaculars whilst the state supported the use of Kiswahili (Thompson 1976). The missionaries' dislike for Kiswahili may have been partly due to its associations with Islam, but their preference for the vernacular was also a pedagogic one. The Phelps-Stokes report (Jones 1925) recommended that the vernacular should be used during the early years and English only introduced at higher levels of schooling. Kiswahili should not be allowed to displace English or vernacular. The rationale for the use of vernaculars drew on the underlying belief of Education for Adaptation that positive aspects of the local culture needed to be sustained through Africanisation of the curriculum. The report argued that:



With full appreciation of the European language, the value of the Native tongue is immensely more vital, in that it is one of the chief means of preserving whatever is good in Native customs, ideas and ideals, and thereby preserving what is more important than all else, namely, Native self-respect. (Jones 1925: 19)

Nearly thirty years later, an evaluation of education in Africa by the Nuffield Foundation and the Colonial Office (referred to as the Binns Commission) also considered Kiswahili to be an unnecessary intermediate language within the education system. Like the Phelps-Stokes commission, the authors recommend that education should start in the vernacular and then switch to English. The report argues that:

... the teaching of Swahili as a second language to children whose early education has been in other vernaculars is a complete waste of time and effort.

(Nuffield Foundation and the Colonial Office 1953: 30)

In spite of these recommendations and the resistance to Kiswahili by some missionaries, Kiswahili became widely used throughout Tanzania and so it became the pragmatic option as the medium of instruction at lower levels. The Government rejected the recommendations of the Binns commission and during the last decade of colonial rule, Kiswahili medium was used for the first six years of primary education. English was only introduced as a subject in standard V and was used as the medium of instruction in standards VII and VIII.<sup>31</sup> At end of the colonial era, English as a subject was introduced to standard III due to popular demand (Cameron and Dodd 1970). In 1967, Kiswahili was made the sole medium of primary education in the interests of national unity.

The choice of the medium of instruction at secondary level has been hotly debated throughout Tanzania's independent history (Brock-Utne and Holmarsdottir 2004; Brock-Utne 2005a). Initially, English medium was retained at secondary level for practical reasons: the secondary education system was still heavily reliant on textbooks, teachers and examinations from the UK. But the intention to introduce

---

<sup>31</sup> Primary education consisted of eight years of schooling, but this was reduced to seven after Independence.



Kiswahili as the medium of instruction at post-primary levels was clear in early policy documents (Arthur 2001). The Presidential Commission of 1982 proposed the introduction of Kiswahili as the medium of instruction at secondary and higher levels of education, but this was rejected by the government and the recommendation was removed from the report when it was finally published in 1984 (Rubagumya 1991). As recently as 1997, the cultural policy of the Ministry of Education and Culture restated the commitment to changing post-primary education to Kiswahili (Arthur 2001; Brock-Utne 2005a), but the Minister for Education and Culture appointed in 2000, Joseph Mungai, had no intentions of changing from English medium education (Brock-Utne 2004, Brock-Utne 2005a).

Following the publication of the report of the Presidential Commission in 1984, the British were invited to investigate the use of English language in education, with a view to possible assistance. The resulting study concluded that only around 1% of form I students had a level of English that was adequate for English medium education and only around 10% of form IV students demonstrated a level of proficiency at which English medium education could reasonably be introduced (Criper and Dodd 1984, cited in Trappes Lomax 1991:99). Instead of recommending that English should be dropped as the medium of instruction at secondary schools, the report recommended that English should be supported, thus paving the way for the ELTSP which the British Council funded from 1987 until 1996.

Criper and Dodd's recommendation to strengthen English rather than to switch to Kiswahili has been the subject of many critiques (see e.g. Rugemalira et al. 1990; Roy-Campbell and Qorro 1997; Brock Utne 2000) and some authors have pointed out that most of the materials for the ELTSP were supplied by British publishers, including the institution that one of the authors of the report worked for (Lwaiitama and Rugemalira 1990).<sup>32</sup> Seen in this light, the recommendations by Criper and Dodd and the subsequent ELTSP could be seen as a blatant case of neo-colonialism. However, a recent interview with William Dodd, the other author of the influential report, puts an alternative light on the debate (Cadogan 2005). Dodd is quoted as

---

<sup>32</sup> Clive Criper worked at the Institute for Applied Language Studies at the University of Edinburgh which provided many of the materials for ELTSP.

saying that they had initially intended to recommend that the medium of instruction be switched to Kiswahili. His decision to recommend the strengthening of English came as a result of his observation that almost all ordinary Tanzanians that he spoke to during the research period were strongly in favour of maintaining English as the medium of instruction. Only the academics at the university wanted to switch to Kiswahili. The recommendation, he claimed, was based on how he perceived popular Tanzanian demand rather than on a desire to forward British interests and influence. Kiswahili education, like adapted education, tends to be favoured by Westerners concerned with educational quality in Tanzania and by a small Tanzanian academic elite, but it is unpopular among Tanzanians in general.

The data from numerous studies shows that the level of English of both teachers and students is a major limitation on the quality of learning in secondary schools. Generally the level of English among both students and teachers is low (Brock-Utne and Holmarsdottir 2004) and severely limits students' ability to understand what is being taught and to participate in lessons as well as limiting teachers' capacity to explain their subjects. Many academics argue that it is no longer feasible to achieve effective learning in the majority of secondary schools using an English medium (Roy-Campbell and Qorro 1997; Roy-Campbell 2001; Brock-Utne and Holmarsdottir 2004; Senkoro 2004).

There is evidence to suggest that the language of instruction is a major determinant of classroom activity. The pedagogical approach observed in lessons conducted in Kiswahili involved much more active student involvement than lessons carried out in English (Renes 1970; Mwinsheikhe 2003; Brock-Utne 2005b). However, if use of English medium is considered to be a limiting factor on pedagogy in secondary schools, this does not account for the observed pedagogy in primary schools. This is largely teacher centred and dominated by rote learning and copying notes despite the use of Kiswahili medium (Rajani 2001:59; Davidson 2005: 221). A further argument used by the proponents of maintaining English as the medium is that the O' level Kiswahili examinations results are not significantly different from the results in English, with less than 30% of students achieving A-C in each subject (Malekela

2000: 68). Malekela implies that the problem is not one of the use of English, but of the teaching of communication skills in general.

The question of medium of instruction is therefore a highly contentious one. There would seem to be very many sound educational reasons for the change to Kiswahili medium, and yet the popular choice is still in favour of English, and hence to suggest Kiswahili medium could be considered to be patronising. Learning English remains inextricably linked to learning *in* English within the public imagination, and these two ideas are only likely to be separated if Kiswahili secondary education could be demonstrated to give better examination performance in English as well as in other subjects. The resistance to setting up such an experiment and the resource levels needed to make it work on a pilot basis (including Kiswahili examinations and text books) make this highly problematic. When a research team applied for permission to carry out such an experiment, their request was turned down by the then Minister for Education and Culture, Joseph Mungai (Brock Utne 2005a).

## **2.6. Societal expectations and pedagogy**

The above discussion has largely focused on changes within the education system, but as Sadler advised in 1900:

...if we propose to study foreign systems of education, we must not keep our eyes on the brick and mortar institutions, nor on the teachers and pupils only, but we must also go outside into the homes of the people, and try to find out what is the intangible, impalpable, spiritual force which, in the case of any successful system of Education, is in reality upholding the school system and accounting for its practical efficiency. (Sadler 1900/1979: 49)

Nyerere (1967) argued that the problems of colonial education were that it was based on assumptions of a capitalist society, encouraging individualistic tendencies and leading to class stratification. In *Education for Self-Reliance*, he envisaged an education system as part of a socialist society where the peasant farmer would be accredited the same level of social merit as the degree holder, and where willingness to serve and local knowledge of farming would be valued as highly as paper qualifications.

*Education for Self-Reliance* and other socialist policies proved unable to bring about this change in society. Dore's theory of the *Diploma Disease* (Dore 1976) explains why the downgrading of paper qualifications in contexts like Tanzania was (and remains) an uphill struggle. Dore uses Tanzania as an example of a 'late development' country. He argues that a characteristic of such countries is that the formal employment sector can only accommodate a small minority of the population. Modern sector jobs come with a wide range of benefits so there tends to be a huge difference in the quality of life of those with jobs and those without. In such a situation qualifications' inflation occurs; job applicants are judged by their paper qualifications rather than on their ability to perform the task. This skews the function of schools towards the gaining of certification rather than towards providing useful skills for later life. Dore describes school learning in such contexts as "meaningless rituals" (1976: 81) where knowledge is valued only for its power to provide answers in examinations rather than any intrinsic utilitarian worth.

The gulf between the quality of life enjoyed by a post-primary educated African and a peasant farmer was large during colonial times and has remained large in Independent Tanzania. Whilst policies such as Education for Adaptation and Education for Self-Reliance saw schooling as a means for teaching skills for rural livelihoods, societal expectations of schooling were for learning that would prepare students for higher levels of education, even when the access to post-primary education remained highly restricted. *The Diploma Disease* provides a good explanation for why policies of adapted education tend to fail under the pressure and popular demand for a modern academic curriculum that is often highly irrelevant to the majority that study it.

The weakness of Dore's argument is that it assumes that rote learning is the most rational approach to preparing for examinations. Examinations, or other forms of assessment, can be designed to test for skills other than memorisation. National examinations may have a huge influence on pedagogical culture, but can also be considered to be a reflection of that culture as they are written by members of the teaching community. It should be noted that prior to nationalisation of the



examination systems, the Cambridge Overseas science examination papers included a significant number of questions requiring skills beyond recall. The papers designed for the Nuffield Science based syllabi had a particularly strong emphasis on comprehension, application and analysis (Wedgwood 2003a). There is evidence that examination styles in Africa have shown convergence since independence towards more recall based testing (Lewin and Dunne 2000). Given that the developments prior to nationalisation were away from testing for recall, but since then have tended back towards recall, it could be argued that the current style of examinations has more to do with an indigenous preferencing of recall as evidence of learning than an inheritance from an imposed colonial education system. With reference to Dore's claims, pressure to perform well in examinations resulting from a restricted formal labour market will tend to make examinations more high-stakes, but it will only make pedagogy more reproductive if the examinations continue to be based on a quantitative, 'banking' model of learning.

## **2.7. Conclusion**

The history of attempts to adapt education to the Tanzanian context shows that an adapted education system is often believed to be a better option by policy makers when considering society as a whole. However, individual interests favour 'modern' education based on Western models. The popularity of Western style education means there is considerable political pressure for an academic curriculum, for expanded access to secondary education and for the medium of instruction at secondary level to be kept as English. Science education is seen as something involving extensive practical work and recent donor supported interventions have tended to promote this idea, albeit with a nod towards improvisation of apparatus from local materials.

The above discussion raises the question of who should decide on the African curriculum. Should the desire among Africans to follow a Western curriculum, including pure science, be seen as an outcome of Western hegemony? Gray (1999) sees the failure of science education to flourish in Africa as a result of inappropriate

imported curricula and teaching methodologies that have clashed with local culture. But one needs to question whether the development of an African alternative would be viable or acceptable to the majority of Africans. When Verran studied indigenous Yoruba mathematics in Nigeria and proposed to the Yoruba that it be taught in schools, her proposal was met with amusement and she realised the paternalism of her proposal (see introduction). In trying to promote Yoruba culture she could also be seen as denying Yoruba children access to conventional mathematics (Verran 2001).

Adaptation by outsiders such as colonial powers or international 'experts' risks the imposition of a Western image of what is African. Leaving education policy to be shaped by popular demand for modernity may mean that it becomes based on an African image of what is Western. The implications of the pursuit of a modern education system are discussed in chapter six in the light of the findings presented in chapters four and five.

A truly Africanist perspective is one that respects the choices that Africans make over what to study and how. As the Binns Commission of 1953 commented:

There is a good deal of unnecessary fear by Europeans of giving European knowledge to the African in its pure European form... Africans themselves are more capable of selecting and adapting from European thought than is frequently realised.

(Nuffield Foundation and The Colonial Office 1953: 82)

The development of education since Independence illustrates that Tanzanians have tended to select a highly theoretical, academic and laboratory based version of science education from the body of European thought. Whether we see this as a submissive acceptance of Western hegemony or a pragmatic response to globalisation, the current pedagogical culture can no longer be treated as an entirely foreign import, but as a reflection of local beliefs about science and learning.

The issues raised in the debate over educational adaptation are also pertinent when considering methodological challenges involved in researching African cultures, especially when the researcher is Western. Can research methodology generated in



the West be applied directly to African contexts? Are there adaptations that need to be made or is the discourse on adaptation dominated by paternalistic sentiments? These issues are discussed in the following chapter along with other methodological considerations.



### **3. Research Design and Methodological Issues**

Just like the proponents of Education for Adaptation, Western researchers of contemporary African culture risk naïve paternalism as a result of romanticised images of traditional African society. Some researchers, fired by a literature denouncing colonialism and the hegemony of Western thought, may deliberately set out to uncover African alternatives to Western ways of thinking. This fixation on otherness and uncorrupted African thought can lead to researchers discarding modern aspects of African culture as colonial imports, and focusing instead on exotic aspects of culture that contemporary Africans themselves consider to be primitive and outdated. On the other hand, research into educational development in Africa may be biased by the assumption that all deviations from the Western model represent deficits and underdevelopment (see chapter one).

Negotiating this balance has been a challenge throughout the problem identification, data generation and analysis of this research. Key to this negotiation process was an ongoing dialogue with Tanzanian educators and an evolving methodology that enabled me to develop my observations and hypotheses according to their input. For this it was necessary to spend an extended period of time at one location and to learn Kiswahili in order to build relationships and trust. I also needed to be flexible in my research design so that it could be adapted according to my emerging theories and my informants' responses to them.

At the heart of this study is a set of interviews and lesson observations carried out with a small sample of established teachers, trainee teachers and teacher trainers. Further contextual data was collected from a range of other informants including former colleagues from the SESS project and key science education professionals. This chapter discusses the methodological considerations, from the practical to the epistemological, that determined my research design.

### **3.1. The methodological challenge of researching education in Africa**

The process of research itself is a cultural activity and it has long been argued by anthropologists, sociologists and even economists that culture should be taken into account in research into development, but until recently there has been very little written on ways in which this might be done (Klitgaard 1994). Stephens (2005) argues that taking culture into account has great potential for improving the quality of educational research in the developing world. He looks at the epistemological and practical issues underpinning this claim. The epistemological question centres around the issue of whether research, as currently conceptualised, is a direct product of Western dominated thinking, and whether it is possible for research to draw on non-Western thought.

As an indigenous researcher from New Zealand, Smith (1999) expresses profound frustration at the dominance of Western research paradigms, but this frustration raises the question of where alternatives can be found. This question is especially pertinent in Africa where the late introduction of writing means that there is virtually no written record of early African thought. Proponents of indigenous knowledge (Ogunbunmi and Oliatan 1998; Semali and Kincheloe 1999) frequently present an image of pre-colonial Africa in which there were well-established African philosophical frameworks. There is an implication that if we could rediscover these African philosophies then we could use them to Africanise research methodologies and overcome the hegemony of Western thought. But in purely oral societies there is little opportunity for complex knowledge systems to develop through the interaction between different thinkers that the technology of literacy facilitates. Wiredu (1998) expresses concerns over the treatment of African cosmology as philosophy and suggests that African traditional thought should be compared with Western folk thought rather than with Western philosophy or science. Jansen (2005b) argues that it is futile to look to the past for an African epistemology. He sees the development of African scholarship as something that needs to be nurtured to enable it to emerge within contemporary African academia. For the present, we may have to be satisfied with research tools and traditions originating from the West, but allow flexibility

within the research process for those tools to be honed and shaped by Africans for the African context. The qualitative research tradition allows for this flexibility and gives more space to the voice of the informant than quantitative approaches.

With any sociological research there is a potentially dangerous gulf between the academic world, immersed in theory, and the outside world in which the social phenomena being investigated take place. Tightly designed research based on theories derived in the academic world may flounder or fail to reveal anything beyond confirmation of common knowledge when used for data collection in the field. The separation between the field and the academy can be particularly acute in doctoral level research on Africa (Wedgwood and Hammett 2005). The problem identification, literature review and research design often take place within a Northern academy and, as a result, may be far removed from the most pertinent issues within the research context. Methodology courses and texts tend to focus on issues related to Western research contexts that may not be applicable in Africa. Furthermore, the geographical separation of the academy from the field means that data collection is often made during a single extended visit, at an advanced stage of the research, so there is limited opportunity for the data to influence the problem identification or research design. Many writers argue that in order to avoid this dislocation the research cycle needs to be an iterative one in which problem identification and research design is constantly informed and reshaped by the data and the emerging theories (Glaser and Strauss 1967; Silverman 1993). Grounding the process of problem identification within the field limits the bias of preconceived theories about a situation that may arise from the literature. Some ethnographers and proponents of grounded theory recommend ignoring the literature to begin with and to avoid early use of theory and concepts (Agar 1996; Dey 1999).

Considering this study as bounded by the dates of my registration as a PhD student, the research design process was largely carried out within the Northern academy prior to going to Tanzania. But, as mentioned in the introduction, the problem identification process actually started while I was working as a teacher trainer in Tanzania. During my work in schools I observed lessons, discussed them with the



teachers and planned lessons together with teachers. I was able to use my experience from this work to inform my methodology and have used all of these methods in the research. When I returned to Tanzania as a researcher I spent the first few months improving my Kiswahili. I also used this time to discuss my research plans with former colleagues. This helped me to reground my research back within the reality of the Tanzanian education system, from where the idea had originally emerged. During this period I also visited the University of Dar es Salaam to discuss my research with local academics working in the area. I carried out a literature search at the library of the Faculty of Education to familiarise myself with the local knowledge base.

One dilemma that I faced in the research design process was whether or not the research should be comparative, looking at British science classrooms as well as Tanzanian ones. Other studies of culture and pedagogy (Stigler and Hiebert 1999; Tobin 1999; Alexander 2000) have taken a comparative approach, repeating the same set of observations and interviews in different countries and using a common framework for analysis to compare them. Comparisons of Western with non-Western cultures of education can help to counter assumptions of the superiority of Western education systems (see chapter one and Barrett 2005). However, in applying a common framework of analysis, aspects of pedagogy for which there is no clear counterpart in another culture may be lost. As Klitgaard (1994) points out, comparison necessarily leads to oversimplification. Two-way comparisons can lead to dichotomisation (Tobin 1999). There was also the practical issue of the scale of this research. Making the work comparative would have halved the time available for research in any one context, thus reducing the depth of the data collected. Even without an explicit comparative strategy, there was an unavoidable element of comparison with my own experiences in science classrooms in the UK, both as a student and as a teacher. This subconscious comparison was a potential source of exotic bias (Silverman 1993) as there is a tendency to focus on what was different and it was necessary to make a conscious effort to record the “taken for granted” aspects of pedagogy in order to avoid this.

### **3.2. Ethical considerations**

Classical anthropology of non-Western cultures is seen by some as a racist and imperialistic discipline (Tobin 1999). As a Westerner looking at Tanzanian culture, a fundamental ethical question of this research is “who am I to do this?” Being an outsider from a different culture confers a comparative advantage in ethnography as it heightens the researcher’s awareness of practices that insiders might miss due to over-familiarity. Indeed, Tobin argues that ‘outsiderness’ is essential in ethnography (Tobin 1999:124). The problem with classical anthropology, however, is that it has been, and largely remains a unilateral enterprise dominated by Western researchers writing about the cultures of the non-Western world, with an almost complete absence of the converse. It seems unlikely that this bias will be significantly altered whilst huge economic imbalances remain. An investigation by Tanzanian researchers into British pedagogical culture would be a valuable exercise for all concerned, and for comparative education as a whole, but it raises another ethical question of whether resources (both national budgets and foreign aid) in a place like Tanzania should be used to support a few university researchers when it might instead be invested in enabling all children to attend primary school.

Partial justification for my remit to carry out research in Tanzania is that, given that it would be difficult for a Tanzanian to gain funding for research in this area, it may be better for it to be carried out by a Westerner than for it not to be carried out at all. Knowledge of unfamiliar cultures can be used to analyse our own culture more objectively. Tobin (1999:124) argues that knowledge of other cultures helps us to expand our sense of the range of ways of doing things and to question taken-for-granted assumptions. He describes this as “making the strange familiar, to make the familiar strange.” Taking this claim, it could be argued that research into the Tanzanian culture of education could help Western donors to consider whether their assumptions about good practice in teaching are universally applicable. Research of this type has what Woods (1996: 73) refers to as ‘immunological capacity’ in that it could be used to guard against the import of pedagogical techniques that are unlikely to work within the local cultural context.

Recognising that this research had the potential to be an imperialistic endeavour motivated me to seek means of 'damage limitation'. It alerted me to the need to discuss every stage with Tanzanian educators. In hindsight: a reciprocal, comparative research design, involving a Tanzanian and a British researcher collaborating to investigate Tanzanian and British science teaching might have been more enlightening and more ethically justifiable, but it is difficult to envisage how this could be possible within current doctoral funding structures.<sup>33</sup>

Western research into non-Western cultures can be considered to be an extractive process with researchers mining valuable data and exporting it back home. Whilst the researcher may use the data to gain income, renown and qualifications, the informants may gain very little from the experience. In order to reduce the extractive nature of research in Africa carried out by Westerners, it is necessary to consider the dissemination process and how the research may be used from the outset. If the research is to be useful to educators and policy makers within the country context it must address questions that are of local concern. There is therefore an ethical obligation for researchers to situate the problem identification process within local discourse, rather than basing it entirely on the discourse of the Western academy or Western dominated development agencies, and to ensure that dissemination takes place in the field and is not restricted to Northern libraries and research journals.

The dissemination process can start during the data gathering itself. Donn (2005) points out that engagement with policy makers during the research design and data gathering process can pave the way for more effective dissemination of the final research findings. Whilst this research was mainly concerned with what takes place in the classroom, it links the analysis of practice with policy discourses, and policy makers were interviewed for their perspectives on the problem. These interviews, as well as providing useful data, provided a forum for dissemination. The greatest interest however, came from practitioners. Generally I found that the richest data

---

<sup>33</sup> I have been highly fortunate to have worked alongside a Tanzanian colleague, also writing his doctoral thesis on secondary teachers in Tanzania (Anangisye 2006), and I am very grateful for his insights.

came from situations where both the informant and I wanted to learn from the experience. In these cases the 'data gathering' process became a bilateral exchange of knowledge and ideas. This enabled me to make my dissemination process an ongoing one, sharing my observations and emerging theories with my informants. This was partly done on an individual basis during interviews and informal conversations. During the last month of my fieldwork I conducted more formal feedback sessions with the schools and colleges. These enabled me to share my findings with my informants and their colleagues and to get their response to my initial conclusions.

Many informants asked for my recommendations, but this presented me with a further ethical dilemma. The initial motivation of the research was to critically analyse the process of importing pedagogical ideas from a Western context to the Tanzanian one. By giving recommendations I would be doing exactly what I was criticising; providing Western solutions to Tanzanian problems. Freire puts the case against dominant powers providing solutions very strongly. He argues that "The pedagogy of the oppressed cannot be developed or practised by the oppressors" (Freire 1972). As a Western researcher, I believe that I have the capacity and the remit to carry out research on Tanzanian teachers' pedagogical beliefs. My Western cultural perspectives may alert me to aspects that a Tanzanian researcher would miss, but I do not believe that I have a remit to suggest how Tanzanian educators should move on from here; this is terrain for Tanzanians. I have therefore limited my recommendations to presenting examples from the data of what seems to work and what does not. It is for the Tanzanian educators themselves to take these further. Where I do have a remit to give recommendations is to Western development agencies promoting pedagogical change in Tanzania.

A further ethical issue of this research regards the anonymity of my informants. For data relating to practice I have made every attempt to ensure informants' anonymity. For data relating to policy, the names are provided as the data relates to their position of authority and in the interviews they were speaking within their professional capacities. Whilst negotiating access I stressed to all informants at the schools that

they would not be identified in the write up and accordingly, all names of schools, tutors and trainees are pseudonyms with the exception of tutors directly involved in TEP. At the feedback sessions, teachers were keen that their schools should be identified, but I have stuck to the use of pseudonyms as identification of the schools would mean identification of the teachers. I have also withheld details of the region in which the research was carried out as this could lead to identification of the schools.

### **3.3. The evolution of the research questions**

As discussed in the introduction, the original research question was derived directly from my experience as a science teacher trainer in Tanzania. I was interested by the apparent lack of impact that a donor-led science education project was having on classroom practice. Schools received in-service training, books and science equipment through the project. These appeared to have little influence on pedagogy in many of the cases that I observed. Some underlying characteristics of science teachers' approach to pedagogy appeared to be resistant to change and these characteristics appeared to be in common with other educational practices in the society. This directed my thinking towards the influence of culture on pedagogy. In writing my original proposal I was almost totally unaware of the literature in this area, although I had some familiarity with Western research on the teaching and learning of science. My initial question was "how does Tanzanian culture influence pedagogy in science teaching?"

After a year of research training and a study into the import of pedagogy from the West to Tanzania during the late colonial and early Independent era (Wedgwood 2003a), and a further year considering methodological issues specific to Africa (Hammett and Wedgwood 2005), the nature of scientific knowledge and reading empirical research on pedagogy in Africa, I was more aware of theories offered by other researchers on the influences on pedagogy in general, and specifically within African science classrooms. These theories provided me with a list of things to look



out for, or nascent theories, as discussed in chapter one. But I chose to keep the scope of the study broad, rather than selecting a single possible theory for testing. Whilst there is a growing body of classroom based ethnographic work in Southern Africa (see chapter one for examples), ethnographic studies of schools in Tanzania (Stambach 2000; Vavrus 2003) have tended not to focus on pedagogy. This investigation was more concerned with 'charting' or 'mapping' cultural influences on pedagogy within Tanzania rather than what Woods (1985:58) refers to as 'phase two' research that sets out to test predefined theories. In the light of the literature I expanded my original question into four further questions, but left them open and exploratory:

- 1) What type of knowledge and ways of thinking do Tanzanian teachers aim to promote in secondary science?
- 2) How does teachers' local knowledge about learning science influence their teaching?
- 3) Are there indigenous models of teaching and learning that conflict with inquiry based science teaching as promoted by the Tanzanian Government and Western development agencies?
- 4) Are there any examples where indigenous knowledge and teaching approaches have been integrated into science education to good effect?

On entering the field, I was immediately struck by the prevalence of the term *njia shirikishi* (participatory methodology) within educational discourse and it became one of my aims to trace the source of this term, what it meant to teachers and how it impacted on their practice. I had not been aware of this term when I previously worked in Tanzania and it was apparently a term that had become much more extensively used among educators between my departure in 2001 and my return in 2004. *Njia shirikishi* became the focus of my third research question, but investigation of this revealed reinterpretation of the term by the different educators (Western facilitators, ministry officials, curriculum developers, tutors and teachers). There was little evidence of actual conflict, but extensive evidence of adaptation.

My fourth question began as a quest for the exotic; looking for the use of pedagogic techniques seldom practised in the West, such as riddles and story telling in classrooms.<sup>34</sup> I discussed this with former colleagues at an early stage in the research. I also put the question to over 50 trainees to discuss during my first week of field research. The responses made it clear to me that this was not a fruitful line of enquiry. Informants were confused and, I sensed, somewhat insulted by the question. Many teachers and trainees saw local/traditional teaching methods as undesirable, regressive and of little value in modern science education. In the light of this I modified the last question to simply look for what works, accepting that contemporary methods developed and adapted by practising teachers are just as indigenous as more 'traditional' methods that date back to pre-colonial times.

I was also hoping to find examples where 'local science' such as knowledge about brewing or local farming techniques were integrated into the classroom teaching (see e.g. Knamiller, Osaki and Kuonga 1995). Teachers were more positive about the importance of local technologies than they were about local teaching methods. But in practice they were constrained by the syllabus and curricular materials, which made little reference to these (see chapter four). Since examinations are written nationally, they rarely ask about or give credit for locally specific knowledge. One primary teacher explicitly told his class not to give local examples (during a brainstorming exercise on types of fruit) as they would not be accepted in the national examination (lesson observation, Mr Njogolo 17/2/05). I gave up on any active search for examples of indigenous knowledge within science lessons, but simply noted the few examples as they emerged during lesson observations. Instead I became more interested in teachers' attitudes to the place of local scientific knowledge in the classroom and considered this as an aspect of their folk curricula.

In light of these findings I reformulated the research questions as follows:

1. What do tutors, teachers and students see as good science teaching (folk pedagogies)?

---

<sup>34</sup>Various writers have argued for the use of these indigenous pedagogical techniques in modern classrooms (e.g. Brock-Utne 1996; Semali 1999).

- a. What types of knowledge and learning do teachers aim to promote in science education (folk curricula)?
  - b. What models of learning guide their practice (folk psychology)?
2. How have local folk pedagogies influenced the adaptation and adoption of Western teaching methodologies to give the concept of *njia shirikishi*?
3. What teaching approaches work to the extent of involving students in quality learning?

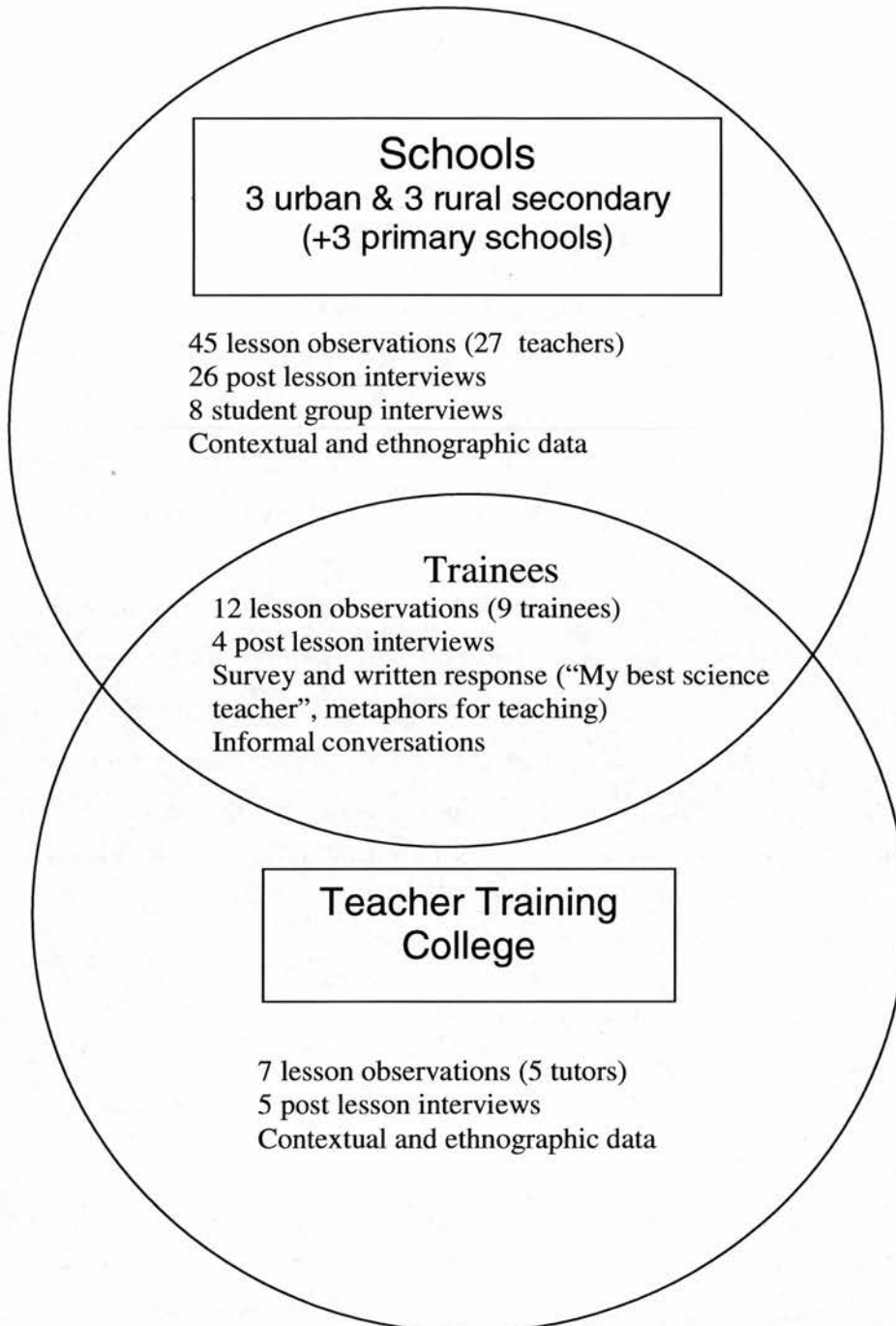
### **3.4. The research site and range of informants**

The main research sites for collecting data relating to practice were six schools and Zebaki teacher training college (TTC). These sites intersected as the trainees taught in the schools and also many of the teachers had trained at Zebaki themselves (figure 3.1). There were three main groups of informants: teachers, trainee teachers and tutors. The number of teachers observed and interviewed at each school depended on the total number of science teachers and their availability. It also depended on the Head of School's response to the research and on the willingness of teachers to be observed. In one of the larger urban schools there were many science teachers, but observations were only carried out with a small sample as both the teachers and the Headmaster showed evidence of research fatigue. By contrast, in one of the rural schools the Headmaster was keen that I should observe all of the science teachers as he saw the process as one that would be useful for their professional development.

I chose to situate myself at Zebaki TTC as it is one of the few TTCs to offer the diploma in science education and, being on the outskirts of a regional capital, it provides access to rural and urban schools. I stayed within the college campus and attended college official and social events on a regular basis. The trainees at Zebaki come from all over Tanzania, and are posted to schools countrywide after completion. The TTC was, as hoped, an excellent point of entry to schools in the region. The college had strong links with schools in the surrounding area due to the teaching practice that is a part of the diploma curriculum. Their advice and

assistance, especially in selecting and contacting the more remote schools, were invaluable.

Figure 3.1: Summary of sources of data relating to pedagogical practice



For two of the rural schools my visits took place while the trainees were there and these visits coincided with visits from the tutors to assess the trainees. This enabled me to work together with the tutors in the assessment of the trainees and to observe the aspects of teaching that tutors were most concerned with. I arranged my rural school visits during the brief teaching practice period. The college has a policy of only sending males on rural placements. This meant that males were heavily overrepresented in the sample of trainees. In order to correct this I observed and interviewed a female trainee at a secondary school near to Zebaki (School X). Unfortunately due to illness and timetabling issues I was not able to observe more female trainees.

One of the sample schools was attached to the college as a practice school; so I saw students and teachers on an almost daily basis. The staff at the school were very welcoming and helpful and this meant that I could drop into the staff room at any time to catch up with teachers or to ask questions that had arisen from my research elsewhere. This 'dropping in' enabled me to observe how school life operated when no researcher was expected. I was often invited into teachers' homes. This gave useful insights into teachers' lives and opportunities for conversations that went beyond school life.

The field research period was around nine months in the country spread over a year (see appendix 1). During this time I was based at Zebaki TTC and made visits to schools in the area. School visits generally lasted a week although in the more local schools the visits were more extended, but less intensive. I also visited three primary schools in order to see what science education took place at primary level and how pedagogy differed when it was taught in Kiswahili. During the June/July school and college holidays I carried out interviews at the Ministry of Education and Culture (MoEC), the Tanzania Institute of Education (TIE) and the National Examinations Council of Tanzania (NECTA). I also visited Morogoro TTC to speak to facilitators of the Tutor Education Programme and other science tutors. In the last month of my



stay in Tanzania I revisited the schools<sup>35</sup> to carry out a feedback session on my findings.

### 3.5. Research methods

As this was an investigation into culture, it was obvious that I would need to draw extensively upon anthropological research methodologies and their applications within educational contexts (e.g. Hammersley 1990; Woods 1996). Much of the data came from casual (i.e. out of class) observations and informal conversations. Whilst this purely ethnographic data is not foregrounded in the following chapters, it guided me in the questions to ask in more formal situations and enabled me to compare what people said with what they did. It enabled progressively focussing on key issues as they emerged (Hammersley and Atkinson 1983).

The main source of data is a set of over 60 lesson observations<sup>36</sup> and 33 follow-up interviews with tutors (5), teachers (27) and trainees (9) (see table 3.1). Each educator, where possible, was observed teaching at least two double periods and interviewed after one of them. The method of lesson observation with a follow-up interview has been extensively used to explore teachers' pedagogical choices (Calderhead 1996). The observation provides both verification of the interview data and gives concrete stimuli and critical incidents to be explored through interview.

**Table 3.1: Sources of data relating to practice: formal interviews and lesson observation**

Institution	Date	Lesson observations	Post-lesson Interviews	Student Interviews
Zebaki TTC	(Oct 04, Jan – Sept 05)	7 (5 tutors)	5 tutors	
Alizeti SS	24/1/05- 7/2/05	8 (4 teachers)	4	2 groups (5+12 students)

<sup>35</sup> I was unable to carry out a feedback session at Edeni due to illness. The feedback at Fadhili was conducted during the main school visit as this was near the end of the research process.

<sup>36</sup> Almost all of these were 'double periods' of 80 minutes, i.e. two 40-minute periods combined, or, in the case of the lessons at the teacher training college, two hours.

Batobato SS	31/1/05- 8/02/05	8 (4 teachers)	3	1 group interview (12 students)
Chambuzi SS	11/4/05- 15/4/05	9 (4 teachers)	4	2 groups (7+6 students)
Dafina SS	28/2/05- 4/3/05	3(3 teachers) + 6 (3 trainees)	3 teachers + 3 trainees	2 groups (3+6 students)
Edeni SS	7/3/05- 11/3/05	2 (2 teachers) + 5 (5 trainees)	2 teachers + 1 trainee	1 group (8 students)
Fadhili SS	25/7/05- 29/7/05	12 (7 teachers)	7 (+2 further interviews)	2 groups (6+6 students)
Primary Schools (3)	17/2/05- 7/3/05	3 (3 teachers)	3	
School X	14/3/05	1 trainee	1 trainee	

Classroom observation involves naturally occurring data (Silverman 1993), and so it is considered by some to have high ecological validity, or what Woods refers to as “fidelity” (Woods 1996). Whether the interaction between a teacher and their class can ever be observed in a wholly natural state is contestable, as the unnatural presence of the observer will influence what goes on (Measor 1985). It is not uncommon for a researcher observing lessons to be presented with a set performance piece (see e.g. Caddell 2002). As my aim was to explore teachers’ models of ‘good pedagogy’ rather than to reveal ‘normal practice’, with all of its externally imposed constraints, I was not overly concerned by the fact that my presence in all likelihood made the teacher more conscientious, but I still felt that it was important to see more than one lesson with each teacher. By observing a number of lessons I hoped to get a closer approximation to “typical” lessons.

Another reason for observing a series of lessons is that teaching is an ongoing process and observation of isolated 40 or 80 minute periods may fail to capture the overall strategy used by the teacher. It is important to discover how the new material is linked to the old and how the teacher evaluates the lesson or follows it up at a later

stage. Unfortunately I was not always able to see consecutive lessons with the same classes due to timetabling issues. A further problem with the selection of lessons to observe was that many periods were taken up with activities such as sitting tests and going over recent examinations rather than presentation of new material. In the larger schools, teachers only taught two different lessons during the one week, but taught them to many separate classes. This limited the variety of lessons available for observation with one teacher during visits. I had originally hoped to observe three separate lessons with each teacher. In practice, I was only able to do this for a minority of teachers. Most teachers were observed teaching two double-periods (160 minutes total).

As discussed in chapter one, categorisation of classroom activities according to teaching/learning methods (e.g. lecture, groupwork, teacher-led question and answer session) does not give a clear picture of the type of learning taking place. Lesson observation schedules listing only the time spent on different activities by teachers and students would not have captured the way that the scientific knowledge was treated. It was necessary to consider the content and the pedagogy together, and to consider how teachers and students made sense of the science. Beyond recording the date, time and subject, I did not use any set structure in my lesson observation notes, I simply wrote down what was said during the lesson and made notes in the margin on peripheral observations, such as whether students had books on their desks, or whether they had desks at all! I also copied down what was written on the board. I sat at the back of the class and recorded these notes in an exercise book (*daftari*) of the same type as used by the students (simply because these were readily available). I used periods when students were working in groups or individually to listen to their group discussions and to look at their exercise books.

Recording lessons by handwritten notes meant that I inevitably failed to record some aspects of the lesson. In terms of the accuracy of my lesson transcripts, the use of English in lessons generally meant that the pace of speech by teachers and students was relatively slow, enabling me to write down verbatim most of what was said. Student contributions were sometimes difficult to hear as they were often quiet and

directed to the front of the class. Lesson content in Kiswahili was much more difficult to record as speakers spoke faster and I was slower at writing it. I was not able to make a good verbatim record of the one secondary science lesson that involved extensive use of Kiswahili. I observed several lessons in primary schools that were entirely in Kiswahili. I found these lessons very difficult to record by hand. The pace of the lessons was much faster and almost all my mental energy was taken up translating the lesson; so I was unable to make extensive notes during the lessons. Had this study been on primary science classrooms I would have had to make audio or video recordings of lessons.

Videotaping lessons has proved a valuable technique in other research into pedagogical culture (Stigler and Hiebert 1999; Alexander 2000; Stoffels 2005), but I had several concerns over using this in my own work. Some of the schools that I visited were in rural areas and a video camera would have been a great novelty and centre of attention.<sup>37</sup> I feared that introducing a video camera into lessons would have made them even more of a performance than they already were. A camera also tends to focus the attention of the user on one specific person or area of the classroom and limits the observer's peripheral vision that could otherwise be useful in picking up details such as whether students were writing or not. By recording the lesson by hand I may have missed some of the aspects of the lesson such as the teacher's tone of voice and intonation, but it enabled the teacher, the students and me to focus on the lesson rather than on the technicalities of recording it. I was also concerned that being seen with expensive equipment would influence my relationship with teachers (see below).

With each teacher observed,<sup>38</sup> I carried out a follow-up interview as soon as possible after one of their lessons. These post-lesson interviews followed the rough structure outlined below:

---

<sup>37</sup> Pryor and Ampiah (2003) found that they were unable to use video recording as a form of data collection in a Ghanaian village. Even after 3 months the camera was such a novelty that it attracted too much attention.

<sup>38</sup> With the exception of one teacher at Batobato.

1. Educational history
2. Reflection on the lesson: the planning process, rationale for pedagogical choices, discussion of critical incidents, assessment of student learning.
3. Planning a hypothetical lesson
4. Any questions?

Firstly, I would ask them to give me their education and employment history. As a prompt, I would give my own educational history first. This provided an opportunity for me to introduce myself and gave the interviewee an uncontroversial and easy subject to talk about. At the same time it provided a useful source of data. Teachers' educational histories shape their thinking about teaching (Eraut 1994). I asked teachers which schools they had attended, their teacher training (pre-service and in-service), their teaching experience, other work that they had done and whether they had done practical work at school or college. This gave an extra source of data relating to life at teacher training college and I was able to triangulate teachers' recollections of their training with my observations of life at the training college.

We then discussed the lesson that had just been observed. I firstly asked how they had gone about planning the lesson and what sources of information they had used. We then went through the lesson and I asked them to explain their rationale for using the pedagogical devices that they had chosen. In some cases there were critical incidents, such as questions raised by students, and I asked the teachers about their responses to these. As the research progressed I began to ask other questions that had arisen from my observations in general. For example, few lessons involved extended copying of notes from the board, but students often had detailed notes in their exercise books. I therefore asked teachers to explain to me their strategies for ensuring that students had a record of the lesson content. I also asked teachers to describe any further work or evaluation of the students' learning that they planned to carry out on the material taught.

After discussing the observed lesson I would ask teachers how they would teach that lesson if they were in a well resourced school with a fully equipped laboratory and many textbooks. On several other occasions I asked tutors, teachers and trainees how they would go about teaching a certain topic such as classification in biology or moles in chemistry. This technique of planning a hypothetical lesson within an interview has been used to explore teachers' mental images of how children learn and how they use this understanding to inform their teaching (Strauss and Shilony 1994). When I used this method in a pilot study with British trainee teachers at Moray House, I found it to be very fruitful (Wedgwood 2003b). It has the advantage over post observation interview in that it enables the teacher to explore pedagogical possibilities not practically available to them in everyday situations due to constraints such as class size, lack of materials and class discipline.

Tanzanian educators generally appeared to find it much more difficult to describe in detail how they would teach given a well resourced class than the trainees in the Scottish pilot study had. What became apparent from the interviews was that the Tanzanian teachers' pedagogy was still limited by internalised constraints. Some teachers referred to doing experiments, but were unable to say what experiments they would carry out. Others spoke of teaching the lesson in the same way, but using better visual aids such as wall charts or videos. Having had very little experience of teaching resources they had very little conception of what teaching in a well-resourced classroom might entail.

At the end of each interview I asked the teachers if they had any questions for me. This was an attempt to make the interview process more reciprocal. Teachers would frequently ask for advice on how they could improve, or ask me how I would have taught the same lesson. Koosimile (2002) had a similar experience when researching teaching in Botswana. Taking the role of the pure observer, he saw this as a problem in terms of endangering the validity of the data that he wanted to collect. I saw my role as more participatory and felt that the potential gains both in terms of insight, into how they reacted to my suggestions, and development of trust outweighed the possible drawbacks in terms of contaminating the data by influencing the teachers'



actions in further observed lessons. Rather than giving my direct opinion of how it should be taught, and thus setting myself up as an authority in the area, I based my answers on my own experiences of what worked in my lessons or what I had seen working for other teachers. As the research progressed I was able to draw on my observations of other teachers and hence feed back some of my findings to informants.

In the schools I held group interviews with students from forms III and IV. One purpose of these interviews was to find out what teaching styles students preferred. I asked the students to think of their best science teacher and, without naming that teacher, to give me the characteristics that made that teacher a good one. I was also able to use the student groups to verify or refute claims made by the teachers, for example about the amount of practical work done in the school or about the use of English in lessons. I asked students about where they got their information from and how they went about making notes.

At the teacher training college I was able to use some of the 'communication and study skills' periods to generate data with the trainees through a range of exercises. Trainees were asked to think of their best science teacher from their own school experience and to write a passage explaining why they thought this individual was a good teacher (79 scripts). I then provided the trainees with a list of 17 attributes of a teacher and asked them to select the three most important and the three least important (67 responses). This list had been adapted from a list in their communication and study skills course materials (unpublished). In hindsight it would have been more valuable to generate a list from the open response scripts, although this would have meant carrying out the ranking exercise on a separate occasion. At a latter session they were asked to work in groups to write down metaphors for teachers, learners and the teaching/learning process (64 scripts, 111 metaphors). This method has been used to examine trainees' pedagogical beliefs (Sugrue 1997).

Following a alternative to interviewing suggested by Bechhofer and Patterson (2000: 62), I investigated the college library to find out which books trainees used. I spoke

to the librarian, looked at which books were kept on the reserve shelves and at the level of wear and tear on books.

In order to understand the approaches to pedagogy that were promoted at a national level it was necessary to familiarise myself with curricular materials. Materials analysed included textbooks, syllabi (for secondary schools and for teacher training), past examination papers and teacher training materials. I also interviewed policy makers and curriculum designers to ascertain what they felt were the priorities in science education and also how they perceived the influence of Western ideas about pedagogy. I carried out interviews at the Ministry of Education and Culture (MoEC), the Tanzania Institute of Education (TIE) and the National Examinations Council of Tanzania (NECTA). Access at the latter institution was highly restricted and I was unable to gain extensive information on the setting of examinations and students' performance on the different types of question. To investigate the introduction of *Njia Shirikishi* I visited Morogoro TTC and conducted interviews with several of the facilitators. A list of individuals interviewed at this level of national policy is given in appendix 2.

### **3.6. Data analysis**

As discussed above, the analysis of the data was partly integrated into the data collection process. After each institutional visit I would transcribe my lesson observation notes and interview recordings into Word documents (see appendix 3 for example transcript). I would reflect on the findings and comment on them, either in the transcripts or in my diary. The data were used for progressive focussing of the research questions (Parlett and Hamilton 1973). As a result, some of the later interviews included questions that I had not asked in the earlier interviews such as where students got their knowledge from and where their notes came from.

Near the end of my stay in Tanzania, I wrote up an impressionistic report, based on my findings, which I presented to the teachers at the feedback workshops (see appendix 4). It should be noted that these are the findings *as presented to the*

*teachers and tutors*. They were aimed at being constructive and not overly critical. Based on my informants' positive response to this initial analysis of my findings, I decided to use it as the basis for a more systematic analysis.

On my return to the UK, the scripts were read and reread. The analysis process was a highly iterative one. Critical incidents and illustrative quotes were copied and pasted into separate files for each emerging category. The final tree of analytical categories is reflected in the structure of the following chapters in which the data and analysis are presented. Transcripts were coded by adding searchable codes to the script, as shown in the example in appendix 3. I used codes as tags to enable me to easily locate phrases or occurrences fitting each category (Ryan and Bernard 2003). Most codes refer to occurrences within the lessons (for example, giving a definition, group work), but in the transcripts the post-lesson interviews were paired with the observation notes so that it was easy to locate teachers' comments about these occurrences. Further notes and reflections were added in the form of footnotes. The transcripts were combined to give four large, searchable documents; one each for teachers, trainees, tutors and students. An index was made for each document and this was used for tallying lessons with certain characteristics, such as lessons involving group work, lessons involving going over examinations and lessons involving misconceptions.

The extended writing exercises carried out by trainees were not transcribed into an electronic form, but were coded directly on the scripts. With the "My Best Science Teacher" exercise, I read through around a dozen scripts in order to generate some initial categories of statements (e.g. pedagogy, relationship with students, outcomes). I then went through each script in more detail listing the teacher characteristics in each category, and tallying to show repeat occurrences of similar characteristic (e.g. he/she used teaching aids, he/she set many exercises for homework). During this process more categories emerged and it was also necessary to adapt the original ones.

With the metaphors for teaching I listed and tallied the scripts according to the metaphorical model (parent, bridge, driver etc.) I also categorised the metaphors by the role assigned to the teacher using the explanations given. The categories of

teaching roles included: teacher as nurturer, teacher as facilitator, teacher as knowledge source and teacher as director. In some cases two different roles of the teacher were given within one metaphor and explanation, and the same metaphorical model was not always explained according to the same role of the teacher. The two most interesting roles for this study were that of teacher as a knowledge source and teacher as a facilitator.

Whilst I have included the analyses of these written exercises in the following chapter, it should be noted that they proved to be of only limited analytical value. They were carried out on a pilot basis, to test whether it would be worth developing and conducting similar exercises with a wider range of respondents. The analysis raised some interesting points that have been used to support other data. It also helped to generate hypotheses to test further through interviews. But also raised many questions about the interpretation and trustworthiness of the data. Given that the exercises had been carried out within the context of a college lesson, were trainees trying to give the “correct” or impressive sounding answers? Were there major differences between my understandings of the terminologies used and trainees’ understandings? Whilst the same questions could also be asked of the interview data, interviews allowed for further exploration and clarification of respondents’ meanings and rationales. I therefore chose to focus on the observation and interview data collection that was proving very fruitful.

I must be conceded that the second written exercise, in which trainees were asked to select the most important and least important characteristics of a good teacher from a list, could have been more illuminative if the items had been written in the light of my emerging findings. Mullhall and Taylor (1997) used a similar ranking exercise to find Tanzanian primary teachers’ views on effective teaching methods to good effect. However, the time used to develop and administer such an exercise would have meant that less time would have been available for observations and interviews.

### **3.7. Generalisability and validity**

Alexander (2000) argues that the deeper underlying factors of pedagogy are culturally embedded, and hence will be typical for that culture. To understand these underlying aspects, a level of detail of data is required which precludes large samples that would be needed for statistical significance. For Alexander, looking at a small sample of classes in detail does not mean sacrificing breadth for depth; the broader, generalisable features of a culture can only be accessed through in-depth study using a small sample size. However, when considering the generalisability of data collected about a culture, it is important to question the boundaries that contain the culture under investigation. These boundaries can vary from the continental to the institutional level. This is a study of the culture of science education in one college and six secondary schools in Tanzania, but I use the observations to describe the pedagogic culture in secondary science nationwide. Whilst I fully acknowledge the rich diversity of cultures within Tanzania, we may be able to speak of a national culture of education when considering secondary schools. The population of any one secondary school often includes representatives from a wide range of regions throughout Tanzania.<sup>39</sup> The central control of curriculum, staffing and examinations also leads to a certain level of uniformity. Only four institutions teach the diploma in science education; so the influence of each college is fairly widespread. Data collected on the culture of education within one region is therefore to some extent representative of the national culture of education. Comparison of the data with my previous experiences of schools elsewhere in Tanzania and with other accounts of secondary school life (e.g. Stambach 2000; Frommer and Weingardt 2003; Osaki and Njabili 2003; Vavrus 2003) support this claim.

Despite this level of conformity, each of the schools visited had their own unique character and ethos. There were marked differences between the urban schools and the rural ones. Some schools had been more influenced by training in participatory

---

<sup>39</sup> Students and teachers were allocated to government secondary schools nationally and were often sent to schools far away from their homes. It should be noted that this situation is rapidly changing as more local day schools are built under SEDP. It is now becoming more normal for schools to draw on local populations (Wedgwood 2005).



methodology than others. By making observations in six schools rather than just one or two I was able to distinguish aspects of school culture that were common across the sample from those that were particular to a specific school or confined to rural/urban schools alone. There is a tendency for much research into education in Africa to take the form of evaluation of particular projects. King (2005) warns against this tendency and commends the research of the 'ordinary' rather than the project. I deliberately chose to study state day schools as these are numerically becoming the norm in secondary education (Wedgwood 2005).<sup>40</sup> I avoided basing the study at Morogoro which has been the centre for the Tutor Education Project. Whilst Zebaki, and some of the schools, did have links with various donor-funded projects, these are so widespread as to be a 'normal' part of life in Tanzania.

A key element of generalisability is the ecological validity of the research (Brock-Utne 1996); to what extent can the behaviour under observation be generalised to unobserved situations beyond the research site? The ecological validity depends largely on the effect that the research process itself had on the actions of the research subjects. Any awareness of being researched is likely to alter behaviour, but changes involving a conscious effort to maintain a certain appearance are unlikely to be sustainable for long periods of time. The length of my stay in each location helped to increase the ecological validity of the observations, especially at Zebaki and the attached school, as the effect of my presence on people's behaviour decreased as I became a familiar figure rather than a visiting researcher.

As reflected in the research questions, this study was more concerned with how teachers thought they should teach than with actual practice, but it was still important to gain a sense of 'typical school life'. Teachers' explicit performance and statements about their own teaching preferences were not simply informed by their own images of good teaching, but also by official policy and their preconceptions about my images of good teaching. By combining information from interviews with students, informal conversations and observations, along with the more structured data

---

<sup>40</sup> Two of the rural schools had boarding facilities but these were officially hostels and were not government supported. The schools were day schools according to their registration with the Ministry of Education and Culture.



collection through teacher observation and interview, I was able to triangulate the different sources of data and gain a more accurate picture of the 'typical' approaches to the teaching and learning of science.

The feedback workshops provided a further source of validation. They were designed to provoke comments, especially where there appeared to be, with reference to my own "folk pedagogy", glaring absences such as the role of students' experiential knowledge. I left these absences without comment to see whether teachers and tutors perceived them as something obvious that I had missed in my findings. I was concerned that if I deliberately brought them to the attention of respondents then they would agree to them as being important because they were aware of them from Western literature on learning. But it was their folk pedagogic knowledge and not their knowledge of Western literature that I was trying to investigate; what they thought was important and not what they thought that academics (like myself) thought was important. Most teachers and tutors agreed with the findings presented. Feedback comments were recorded and, where relevant, have been included in the analysis in the following chapters.

Informants' perceptions of me influenced both the level of access that they allowed me, and the self-image that they chose to portray. As Silverman points out (1993: 94), interviews are social events based on mutual participant observation, and informants' responses were largely determined by how they perceived me. It was important to consciously manage my own habitus in order to present myself to informants as someone with whom they could safely share their thoughts about teaching. Most teachers had only experienced observation in the context of assessment, either by tutors during their diploma course or by inspectors. I made a point of emphasising that the observation and interview were nothing like an inspection, and that I was not there to assess or criticise their teaching, but wanted to understand how Tanzanian teachers in general taught science.

I let teachers know that I had previously taught science in a poorly equipped school in Tanzania in order to stress that I empathised with the frustrations and limitations of their work places. The habitus of fellow educator proved very helpful in building

rapport with teachers and tutors, although the tutors appeared much more threatened by my presence than the teachers and it was much more difficult to gain access to their classes. As a result of this I carried out far fewer observations in the teacher training college than I had hoped to (see table 3.1 and chapter four). My association with the tutors made it more difficult to interview the trainees. I accompanied the tutors when they visited the trainees on teaching practice. Trainees were assessed on the lessons the tutors observed so they tended to see me as an examiner. When I tried to carry out formal post-observation interviews with the trainees it was apparent from the first few that they felt very uncomfortable, especially when I asked to tape the interviews. In response to this I abandoned the formal post-lesson interviews for trainees. Instead I carried out less structured debriefing discussions with them and did not make any records (notes or audio recording) during these discussions.

My approach to the research was deliberately 'low-tech'. I used public transport and recorded my observations in cheap notebooks, in contrast to donor-funded evaluation teams who tend to arrive in private vehicles armed with expensive equipment. In this way I hoped to be seen as more of 'one of us' (teachers) than as 'one of them' (donors, policy makers). Although the work is not in a particularly contentious area there could have been issues over which teachers disagreed with the official line and resisted change. Teachers were unlikely to reveal these to me if they associated me with those promoting pedagogical change. By gaining the trust of teachers I hoped to gain access to these 'hidden transcripts' (Scott 1990). Points of resistance with official policy did emerge during casual conversations in the staffroom or in teachers' homes. However, as already commented above, I encountered very few examples of explicit resistance to the concept of *njia shirikishi*. In relation to accessibility and trust, I cannot be certain that the apparent acceptance of *njia shirikishi* was real, and not merely an artefact of informants' lack of trust. However, given the level of access they allowed me in other areas, this would seem unlikely.

For some of the background information in this study I have drawn on official statistics. These may need to be treated with some caution as there may be hidden agendas among all those involved in collection and reporting the data and they may

often be inaccurate (Samoff 1991). Since official statistics are mainly only used as contextual information within this study their reliability does not impact significantly on the findings presented here.

### **3.8. Objectivity**

Hammersly and Atkinson (1983) argue that the researcher's objectivity can come partly as a result of unfamiliarity with the group studied. They argue that:

Ethnography exploits the capacity that any social actor possesses for learning new cultures and the objectivity to which this process gives rise. (1983: 8)

They describe the approach taken by naturalism as one in which the researcher avoids the influence of their own subjectivity and bias by avoiding causal explanations and by limiting the research to cultural description. They argue that, if it is accepted that culture members are rational and can give causal explanations, it is paradoxical not to let researchers do the same. They suggest that the attempt to produce uncontaminated data by remaining neutral as an observer is not possible. Bourdieu emphasises the inescapability of the influence of an individual's own culture on their patterns of thought. He describes the futility of trying to step outside our own culture.

As the light dove might imagine that it would fly better in a vacuum, the thinking individual likes to dream of thinking free from this unthought deposit that has formed within him, under the rod of his mentors, and which underlies all his thoughts. (Bourdieu 1971: 205)

Agar (1996) sees researcher bias as inevitable and attaining objectivity should involve examining what kind of biases exist and bringing them into the open. Throughout this research I have made a conscious effort to reflect on the ways in which my background has biased my observations and my analysis of them. As mentioned earlier, there was an implicit comparison in all my observations with the culture of education that I had experienced in the UK. Where I feel it is necessary, I have included autobiographic data in order to make the main sources of bias explicit.

### 3.9. Language considerations

A major methodological challenge facing any researcher of African culture is that of language. Mbembe bemoans that in much research of African societies: “Knowledge of local languages, vital to any theoretical or philosophical understanding, is deemed unnecessary” (Mbembe 2001: 7). As Mbembe indicates, key aspects of culture may only be fully understood through the local language, and yet the huge variety of local languages in Africa means even national researchers may not have access to all of the vernacular languages represented in a single secondary school class. The extensive use of Kiswahili in Tanzania makes the problem less acute than in other African countries lacking an indigenous *lingua franca*, although the problem still remains as to whether interviews should be carried out in English and Kiswahili. The official policy of using English medium at post-primary levels means that Tanzania is often considered to be an ‘anglophone’ country, despite the fact that only around 5% of the population speak English (Brock-Utne 2000: 174). It is therefore tempting for anglophone researchers to assume that research can be conducted in English, especially when researching post-primary education. In practice, most of secondary school life takes place in Kiswahili (see chapters one and five). In order to access much of the discourse in schools it was necessary either to work through a translator or to become fluent myself. To work through a translator would not have been diplomatically acceptable since all secondary schooling is officially in English, therefore it was necessary to improve my Kiswahili.<sup>41</sup> I found that fluency in Kiswahili was of great advantage in building rapport and establishing research relationships, and hence it greatly increased my level of access.

From my previous experience I knew that teachers were much more relaxed speaking in Kiswahili and I hoped that by using Kiswahili in interviews I would have greater access to their folk pedagogies rather than their espoused pedagogies learned in teacher training colleges. According to Stephens (1990: 78), bilinguals tend to recall experiences in the language in which they experienced them. So, whilst teachers were likely to remember their ‘official’ pedagogic theories in English, the language

---

<sup>41</sup> I already had a conversational level of Kiswahili from my earlier work in Tanzania but I was not proficient enough to carry out interviews in it.

of instruction at teacher training college, their more personal, local understandings might be more easily discussed in Kiswahili. However, during interviews where I used a recording device the tutors, teachers and trainees preferred to use English. Knowledge of English is an important part of the professional image of secondary school teachers and they did not want to be recorded on tape discussing their professional lives in Kiswahili with an English researcher. Once the recording device was switched off, our conversations often switched to Kiswahili. The irony is that the conversations in Kiswahili, as opposed to those in English, were the ones that it would have been most valuable to record electronically as it was much more difficult for me to make notes or accurately memorise them.

For the student group interviews I gave the students the option of using Kiswahili or English. Most groups opted to use Kiswahili and they were happy to be recorded, but a few groups chose English. The English interviews were less productive as the responses were often limited to one-word answers, and it was difficult to get some group members to contribute at all. Those conducted in Kiswahili were more productive and I recorded them digitally, as I was aware of the difficulties in taking notes in Kiswahili. Whilst a period of language study enabled me to become reasonably fluent, I felt that it was dangerous to assume that my fluency was sufficient to accurately capture all the nuances of these Kiswahili conversations. Even with high quality translation, there can remain an issue of conceptual equivalence where a word in one language and cultural context carries meanings and inferences that are not captured by the 'equivalent' word from another language. In such cases language can provide useful data in itself, rather than acting as barrier. Serpell's work on the local words used for 'intelligence' in Chewa culture is an example of this (Serpell 1993). In order to gain fidelity of translation I employed a graduate teacher as a research assistant. He transcribed the Kiswahili interviews from the tapes and we translated the scripts together. This led to some valuable discussions on the use of Kiswahili terms for wisdom and learning, and also revealed a great deal about his own pedagogical beliefs.



### **3.10. Concluding comments**

The methodological approach that I took involved entering the field with a relatively open mind and an open set of research questions. The research aimed to chart the field rather than to test specific hypotheses. There is a tendency for academic literature, including that on education in Africa, to be dominated by Western viewpoints and an open approach enabled me to take Tanzanian viewpoints into greater account. Whilst the research design and literature search took place mainly within a Northern context, my questions and nascent theories were informed largely by my own experience of working with Tanzanian teachers and hence they were grounded within the field and not just within academic discourse.

The research methods that I used were also informed by my experience of working as a teacher trainer. My experience of using a combination of observations with follow-up discussions from a training context alerted me to its potential as a research method. In using it for research, I rediscovered its potential for professional development. School Heads were enthusiastic that I worked with their staff. Teachers, whilst sometimes nervous to be observed, seemed to genuinely appreciate the opportunity to talk about their work. Although I avoided giving advice, the work became more reciprocal as it progressed. This meant that some of my some of my ethical concerns over the extractive nature of the research were resolved naturally.

Whilst I have tried to be responsive to the views of Tanzanians, the analysis has been largely guided and informed by my own cultural background. I checked some of my initial conclusions with informants at the feedback sessions, but my analysis has moved a long way beyond these. I could not claim that a Tanzanian researcher would have drawn the same conclusions from the data or that they would have noticed the same things when making observations. Whilst I have considered the viewpoints of my informants in the analysis presented in the following chapters, this is still the view of a Western outsider. My 'outsiderness' has enabled me to be more critical of Tanzanian pedagogical practices, but may have led me to some conclusions that my informants would contest.



## 4. Sources of Knowledge in the Science Classroom

Everything we do stresses book learning, and underestimates the value to our society of traditional knowledge and the wisdom which is often acquired by intelligent men and women as they experience life.  
(Nyerere 1967:13)

This chapter looks at where teachers and students in the science classroom drew their knowledge about how and what to teach and learn. It starts by looking at teachers' own education and finds that while the teachers had been drawn from an educated elite, their understanding of science was weak, when measured by national examinations or from observed instances in teaching. They entered teacher training with poor communication skills in English and very limited experience of doing practical work in science.

It then explores the knowledge that teachers gained at teacher training college. The official curriculum is compared with the curriculum in practice and the potential influences on certain aspects of teacher behaviour are considered. Participatory teaching methodology was promoted and lessons were interactive, but tutors tended to only accept trainee inputs that matched the syllabus materials closely. This reduced the potential for trainees to contribute their experiential knowledge to classes. Opportunities for trainees to learn through practice, observation and reflection on experience were very limited. Opportunities for practising teachers to share the knowledge developed through experience were also limited.

The chapter then looks at the sources of knowledge that were available to teachers in schools. Teachers' attitudes to scientific knowledge reflected tutors' attitudes to pedagogic knowledge in that theory was valued over experience. Many teachers in the study were keen to employ participatory methodology and endeavoured to encourage students to contribute towards the knowledge in the science classroom. The type of knowledge that was accessed was predominantly textbook knowledge drawn from a narrow range of accepted textbooks and old notes. The adherence to a set text can partly be explained by the fragility of the teachers' subject knowledge and their limited access to a wide range of knowledge sources, but cases within the

study suggest that a more holistic explanation may be needed that takes into consideration the culture of education that has developed through the intergenerational transfer of knowledge in a context of resource scarcity.

#### 4.1. Teachers' own education

The vast majority of teachers at secondary schools in 2004 were diploma holders (MoEC 2004a). Most prospective teachers enter a diploma course directly after finishing their A' levels or following a period of teaching at private schools or as volunteer teachers at state schools<sup>42</sup>. The table below shows the training and experience of the teachers interviewed for this study.

**Table 4.1: Summary of training and experience levels of sampled teachers**

School	No. teachers in sample	Post- Secondary teacher training			Years of teaching experience		
		Diploma	Degree	In-service training	Less than one year	1-4 years	5 + years
Alizeti	4	4		1	1	1	2
Batobato	4	4	1	4			4
Chambuzi	4	3	1	4			4
Dafina	3	3		1	1	1	1
Edeni	2	1			1	1	
Fadhili	7	5			3	4	

In this sample of 24 teachers, three had no formal teaching qualifications, 19 were diploma holders without degrees and two had degrees. Of the 20 teachers with diplomas in education, the majority (16) had studied at the local teacher training college, Zebaki. four had taught in private schools or as volunteer teachers before enrolling on the diploma course. One had trained and worked as a civil engineer before becoming a physics teacher. Those who had graduated from high school before the mid 1990s had done two years of national service before starting the course, but the rest had entered teacher training (or teaching) straight from school.

<sup>42</sup> Volunteer teachers are paid a small subsistence wage from the school account and given accommodation.

The motivation for enrolment at a teacher training college was rarely a vocational one and teaching was often seen as a last resort (Sumra 2006). In a recent survey only 12% of diploma trainees claimed to have followed teaching as a first choice of career, with the main barrier to other career paths being low grades at A' level (Towse, Kant et al. 2002). The quotes below are typical of many comments that teachers and trainee teachers made to me during my time in Tanzania. Frequently these comments were in the context of conversations that the trainees and teachers initiated about seeking ways to go to university in order to follow a different career.

I can say that teaching is the last...um last....if you look at teachers they are not living well.  
(TTC trainee, 19/10/04)

A lot of teachers in Tanzania become to be the teachers due to the hard situation they pass, may be after miss the chance to university where they aimed to be engineers, accountants etc.  
(TTC trainee, "My Best Science Teacher")

I am not a teacher by choice, it just happened- other jobs are better pay for less work.  
(Teacher, Alizeti School 28/01/05)

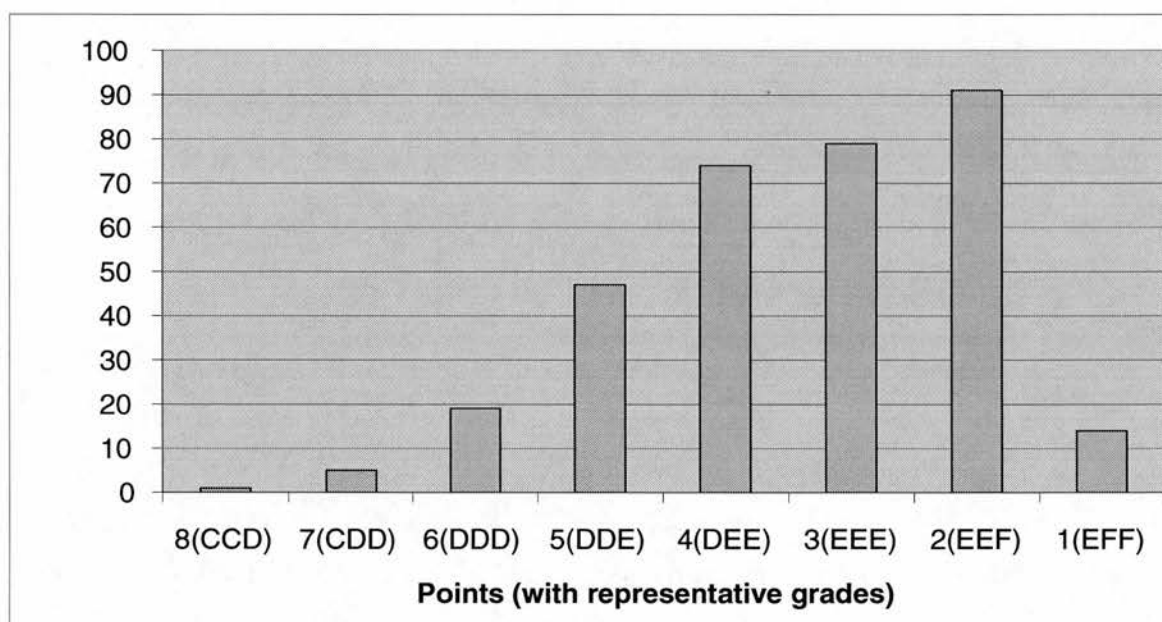
Universities tended to take the vast majority of students with two A' level passes at grade C or above and diploma courses in vocations other than teaching (e.g. accountancy) also took many of the better A' level students (Wedgwood 2005). As a result of both limited supply of form VI leavers with good grades and the unpopularity of teaching as a profession among high school graduates, those entering teacher training tended to be the ones with grades only barely above the official minimum (two grade E's). Even with such low entry criteria, Zebaki TTC struggled to fill all of its places and sometimes took on trainees who had failed the A' level in one of their teaching subjects on the condition that they re-sat the A' level examination. Even with such trainees, the college was still working below capacity.

Figure 4.1 below shows the A' level scores of the trainees at Zebaki TTC who were enrolled during the academic year of 2004/2005. The scores given are those used for university entrance, with grade A=5, B=4 points etc., giving the total for the three



main subjects sat.<sup>43</sup> The mean A' level score of trainees at Zebaki in 2004 was 3.4, equivalent to just slightly better than three E's. The majority of trainees had scored 3 points or less at A' level (equivalent to EEE). Around a third (31%) had the equivalent of only two passes at grade E. It was not uncommon for trainees to have failed the A' level examination for one of the subjects within their combination. The mean for the first year (3.3) was slightly lower than for the second year (3.5). As the pressure on colleges to accept more trainees increases under the Secondary Education Development Programme (SEDP) it is likely that the average A' level grades of teacher trainees will continue to fall.

Figure 4.1: Zebaki TTC trainees' A' level grades (2004)



The number of students starting A' level courses in 2004 was 17 200 and the number of students completing form IV in 2003 with a division II or above (indicating a grade C average or above) was 9042 (MoEC 2004a). These figures indicate that many students enter A' level courses with grades at O' level that average below C. Looking at the 2005 form IV selection for Batobato school (NECTA 2005), the majority of students selected to study science subjects had C or D grades in the

<sup>43</sup> Pass grades are from A to E, F is a fail. The maximum score possible is therefore 15 (AAA). A score of 5 could represent a range of possible grade combinations including DDE, CEE, AFF etc.

subjects they were due to follow at A' level. For example, of the 32 students selected to study biology at A' level, only 5 had scored B and none had score A at O' level. Assuming that the candidates with lower grades at O' level would generally be the ones with the lower grades at A' level, it can be inferred that the majority of trainees entering teacher training in recent years would have scored a C or below in their O' level sciences and an E or below in their A' levels before going on to study a diploma teaching course.

It should be remembered that within the Tanzanian context a grade C at O' level is a great achievement that only the most able students are capable of. For example, less than 25% of biology candidates achieved a C or above in 2004. On a national scale, teachers are still being drawn from an academic elite. They come from the upper 2% of the population<sup>44</sup> that make it to high school. What is at issue here is that this data implies that the average Tanzanian science teacher would have experienced an education where they were unable to master much of the syllabus that they were expected to learn. A grade C represents a mark of around 50% (41-60%) in the examination; so many teachers would have only been able to answer around half of their O' level paper correctly, and this is the material that they are now expected to teach. Given their academic achievement relative to the rest of the population, their low performance is unlikely to be due to a lack of native ability or academic drive and hard work; but is more likely to be symptomatic of an impoverished education system and/or a syllabus that is poorly matched to the capabilities of the students and the delivery system. What matters in terms of the implications for their teaching is not only that teachers have a very fragile knowledge base for the material that they are teaching, but also that they will have become familiar with the experience of not understanding material that is covered. This familiarity with partial incomprehension could be passed onto their own students through their teaching. Instead of teaching for understanding, teachers may teach for survival in the examinations.

Further evidence of the impoverished secondary education that many teachers experienced came from the teacher biographies. Around half of those asked (11/23)

---

<sup>44</sup> Gross enrolment ratio (GER) for form V-VI in 2004 was 2.1% and net enrolment ratio (NER) was 0.5%. Here I have taken the GER in order to include students older than the official high school age.

claimed to have not done any practical science at all at secondary school (O' level). All had done some practical work during A' level studies as there is a compulsory practical examination. Many claimed to have not done any practical work at teacher training college. This meant that some teachers had huge gaps in their knowledge base on how to carry out practical science at the level at which they were teaching. One teacher, for example, admitted to me that the lesson I had just observed had been his first time ever to perform that experiment. He had observed it for the first time the week before when a trainee teacher from the university had carried it out during teaching practice at the school. The comment below was typical of many that younger teachers made to me.

I have not seen a micrometer screw gauge up to now or Vernier calliper. I know how to use them theoretically, but I have never seen them.  
(Mr Kigula, 26/1/05)

As well as entering teacher training with weak subject knowledge, trainees were hampered by their limited ability to communicate in English. All of the trainees would have studied from form I to VI in English medium and English as a subject up to form IV. However, as discussed in the following chapter, very little of the discourse in secondary schools was in English, even within the classroom. Performance in English O' level was not as bad as in the sciences and mathematics, but the percentage achieving above a grade C was very small. At Fadhili school, where the results for English in 2004 were well above the national average, only two of the 151 students scored above grade C in English. From casual conversations with trainees at the college it became apparent that many felt uncomfortable speaking in English and most chose to switch when they found that I was fluent in Kiswahili. When I was invited to give a speech at a pre-graduation party for a group of trainees, I was specifically asked to speak in Kiswahili as, according to the representative, some of the trainees would not understand me well if I spoke in English. Some trainees' ability in written English was also very restricted as illustrated by the passage below, written by a first year trainee when asked to give a written description of his/her best science teacher.

About I, the most and good teacher who taught science subject she/he all who was taught when I was O'level school. Because they were taught me well by

using practical instruments and more explanation about the science subjects and were taught me its application on my future and daily Arithmetic life. (“My Best Science Teacher” 1<sup>st</sup> year Zebaki trainee)

Potential science teachers generally entered Zebaki TTC with a weak base of subject knowledge, poor communication skills in the language of instruction and often very little experience of carrying out practical work.

## **4.2. Teacher training at diploma level**

### **4.2.1. The official curriculum**

The curriculum in teacher training colleges in 2004/05 was based on the curriculum introduced in 1997. According to this curriculum trainees spent roughly equal amounts of time studying various generic aspects of education and studying classes on their chosen subject areas, with each trainee studying two secondary school subjects. Until 2000, the subject specific courses consisted mainly of academic subject content at a standard roughly equivalent to A' level. There were also elements of subject specific pedagogic knowledge and 40% of the final examination was on this area. In 2000, new syllabi for the subject specific courses were introduced that focussed entirely on pedagogy, although it was to be taught in the context of the subjects. From 2000, instead of studying “chemistry” or “biology”, trainees studied “chemistry teaching methods” or “biology teaching methods”.

The period allocation at Zebaki (see table 4.2) closely followed the one given in the Ministry of Education and Culture guidelines (MoEC 2000a), with the addition of Communication Skills as a compulsory subject. Additionally the Ministry guidelines say that there should be 6-8 weeks of teaching practice in schools each year.

**Table 4.2: Subjects and time allocations at Zebaki TTC**

	No. of hours per week
Subject teaching methods option 1	5
Subject teaching methods option 2	5
Educational psychology	2
Curriculum and teaching methods	2
Foundations of education	2
Educational management	2
Educational research, measurement and evaluation	2
General studies	2
Religion	1
Communication Skills	2

All subjects except for Religion and Communication Skills were examined at the end of the 2-year course through a paper examination administered by NECTA. Trainees had to pass all 8 subjects in order to qualify for a Diploma in Education. They were also required to pass their teaching practice. This was assessed by two lesson observations by a college tutor. In 2004 the pass rate was 85% with 9% of candidates being referred (needing to re-sit one or more paper). Only 3% were classed as outright fails (MoEC 2004a).

The syllabus for *Curriculum and Teaching Methods* was published in 1997. It gives the topics and instructional objectives along with the teaching and learning strategies and suggested teaching and learning resources. Flip charts, marker pens and Visualisation in Participatory Programme (VIPP) cards are suggested for almost every topic. These are all items that I have observed being used extensively in donor run workshops<sup>45</sup>, but few teacher training colleges had budgets to cover their use in every day teaching. Aspirations to imitate ‘modern ways’ of training, as modelled by the donor led workshops, appear to have had a greater influence on the syllabus design than the realities of training large groups with limited resources.

---

<sup>45</sup> The VIPP method for running workshops involves participants writing their ideas on pieces of coloured card of different shapes and sizes. It originated in Germany, and was applied to international development training. It has since become a popular method of training in the international development agency community, partly through a UNICEF manual (UNICEF Bangladesh 1993).

The term “participatory teaching methods” is frequently used, both with reference to how the course should be delivered and with reference to the type of teaching methods that it aims to promote. Most of the teaching and learning strategies given involve brainstorming or group work, often with groups writing out their ideas on coloured cards (VIPP cards) to be stuck onto flip chart sheets. The group work is then presented to the class either orally or through a gallery presentation. The syllabus then directs: “Tutor to summarise presentations with additions where applicable, by stressing on...” and then goes on to give a list of the desired outcomes of the group discussion (e.g. MoEC 1996d: 23, 24, 25,27).

In the topic on teaching methods the syllabus gives a list of what the authors see as “participatory methods” and contrasts these with “expository methods”, as follows:

<b>Participatory methods</b>	<b>Expository methods</b>
-role plays	-lecture
-demonstrations	-question and answer
-case studies	-story telling
-film shows	-songs
-simulations	-chalkboard notes and talk
-games	(CBNT)
-debates	
-group discussions	
-group assignments	
-projects	
-study visits	
-experimentation	
-discovery/problem solving	
-brainstorming	

(MoEC 1996d: 39)

Following the objective of classifying teaching methods, the syllabus states that trainees should be able to apply the participatory ones in classroom teaching situations. The course module for curriculum and teaching methods, which was produced by TIE as a guide for tutors, discusses the dangers of using expository methods:



This traditional type of teaching encompassed the methods outlined in category B (expository methods)...Educational theorists have termed this method of teaching as 'teacher-telling strategy' and point out some risks associated with it...whenever it is possible learners will misunderstand, misinterpret and miss altogether what teachers tell them.  
...To avoid these risks and ensure that learners learn what they are supposed to learn, the former category is now widely used in teaching. The methods outlined...ensure learner's full participation in the teaching-learning process.  
(sic)  
(TIE 1999: 60)

Within this categorisation there are some surprises for the Western observer. Notably, certain activities that involve students passively listening and watching, such as demonstrations and film shows have been classified as participatory, whereas activities such as story telling and songs, in which all students can actively participate, have been classified as "expository". It appears that the meaning of the term "participatory teaching method" to the authors of the curriculum equates with whatever is 'modern' whereas 'traditional' methods have been labelled expository and are considered undesirable as it is claimed that they do not lead to such positive learning outcomes. The term "participatory methodology" appears to have been reinterpreted by Tanzanian educators to give it an emphasis on modernity and resource intensive methodology rather than an emphasis on the level of involvement that students have in class. This is a clear example of how pedagogical terminology and methodology imported from Europe<sup>46</sup> have been adapted during the process of adoption. The direction of the adaptation is counter-intuitive to the Western observer as it is moving away from Western images of an African culture of education (songs, story telling) and towards Tanzanian images of a Western culture of education (film shows, experimentation). This image of modernity is discussed further in chapter six.

As mentioned above, additional resource materials known as 'modules', or *moduli* in the Swahilicised form, have been written to give further guidance for tutors delivering the syllabus. These modules are unpublished materials and were originally produced by TIE as spiral bound handbooks for tutors. These documents are, in effect, expanded syllabi as they follow the syllabi exactly, giving the same reference numbers for each section.

---

<sup>46</sup> Predominantly Sweden in this case, see chapter 3.

The subject teaching methods syllabi start with material similar to the generic *Curriculum and Teaching* course and then go through selected topics in the O' level syllabi, looking at how to apply different teaching methods to them. In the *Chemistry Teaching Methods* syllabus, for example, around a half of the syllabus is dedicated to looking at ways of teaching parts of the O' level syllabus. Under the O' level topic of *oxygen, hydrogen and water* the objectives given are as follows:

The trainee should be able to:

- Design an experiment which can be used to teach preparation and properties of oxygen gas.
- Demonstrate how to use question and answer strategies to teach the uses of oxygen.
- Demonstrate how to use experiment to teach the preparation of hydrogen gas and its properties.
- Extrapolate on discussion can be used to teach the occurrence (sic) and nature of water, importance of water, as well as water treatment and purification.

(MoEC 2000b:21-22)

The teaching methods that trainees are expected to be able to apply to various topics include demonstration, observation, experiment, research, role play, discussion, 'participatory lecture', games, projects, question and answer and field visits. The most common teaching methods given are demonstration and performing experiments, although use of question and answer and discussion are also frequently mentioned. The syllabus therefore aims to equip trainees with the knowledge and skills that they need to teach chemistry predominantly through class experiments and teacher demonstrations, and class discussion.

In acknowledgement of the lack of equipment in schools, the diploma syllabus includes a section on the improvisation of laboratory equipment from local materials. Elsewhere in the syllabus, it suggests teaching strategies that would be unfeasible in almost any school, let alone a poorly resourced Tanzanian one. For example, objective 3.12.3.2 (MoEC 2000b: 26) expects trainees to state how to plan and organise a field visit to teach the application of volumetric analysis in a real life situation. Few schools anywhere would be able to visit a commercial or government

laboratory where this takes place. According to the syllabus (objective 3.8.1), trainees should know how to use demonstration to teach atomic structure. In science teaching, demonstration generally implies the teacher performing an experiment, as it does elsewhere within this syllabus, but experiments that clearly show atomic structure involve equipment that is beyond the budget of many Western schools.

The secondary science syllabi also give similarly unrealistic suggestions of practicals to carry out and apparatus to use. This gap between aspirations and reality is discussed further in chapter six.

#### **4.2.2. The curriculum in practice**

At Zebaki TTC lessons ran from 7.30 a.m. to 2 p.m. The trainees were generally taught as a year group. For the generic courses this meant that the class size was 195 in the first year and 124 in the second year. For the subject methods courses the class sizes were between 50 and 120. Most tutors were time-tabled to teach around 10-12 hours per week. Science teaching methods classes were taught in the laboratories of which there were two; one for physics and one for chemistry and biology. Given these class sizes, it is not surprising that the teaching strategies suggested in the syllabus were not often followed.

As in schools, most of college life took place in Kiswahili. Staff meetings, assemblies and administrative matters were all carried out in Kiswahili. Much of the teaching was also carried out in Kiswahili, even when I was present as an observer. A tutor told me that this was acceptable in teacher training colleges as the trainees already knew English so did not need the constant reinforcement that was needed at secondary school. As the discussion above indicates, there was great room for improvement in trainees' English speaking skills, but communication in Kiswahili required far less effort and ensured greater comprehension. The use of English was almost entirely reserved for the transmission of the material in the modules and its reproduction in the final examination.

Much of the general educational theory curriculum appeared to be delivered through lectures, albeit with some questions and answers. I never saw a flip chart or VIPP cards in use, either in the lessons I observed or the lessons that I saw taking place whilst moving around the campus. The science methods courses had smaller classes that allowed for some group work. Of the six science methods classes that I observed, four involved group work. Two involved the trainees carrying out some hands on practical work and one involved a demonstration. It is very difficult to judge to what extent these activities were performed for my benefit. Discussions with trainees and graduates of the college gave mixed reports, but most implied that there was little, if any practical work carried out under normal circumstances. I frequently passed by the laboratories. With the exception of one tutor, there was rarely any evidence of practical work being undertaken. A considerable amount of time was spent covering non-subject specific elements of the subject teaching methods syllabi (pedagogic knowledge), with learning objectives that included defining terms such as participatory methods, non-participatory methods and categorising curriculum materials as textual and non-textual. In chemistry, for example, trainees only started covering teaching methodology in the context of the O' level chemistry syllabus (pedagogic content knowledge) when they reached the second year. Some of this course content, such as definitions of terms like "curriculum" and "textbook" and analysis of what each should contain, was covered three times; in the two subject method courses as well as in the *Curriculum and Teaching* course. Tutors were aware of this situation, but continued to follow through the syllabi religiously, seeing it as a fault of the curriculum, and one that they had no power to remedy.

Gaining access to observe the science tutors was generally much more difficult than gaining access to observe teachers in schools. To a large extent this was due to the tutors failing to attend their periods. Generally tutors missed their periods for legitimate reasons. Two of the science tutors were on the senior management team. As the college principal was absent for the majority of the time<sup>47</sup>, these two members of staff were constantly having to deal with administrative issues and were unable to

---

<sup>47</sup> Civil servants are paid very generous per diems to attend to meetings away from their workplace. This makes it in the interest of educational officials such as college principals to attend as many out of workplace meetings as possible (Kerr 2006).



attend their lessons. All were frequently called upon by the Ministry to deliver or attend training workshops that were part of donor funded projects or programmes for primary as well as secondary education. One tutor in particular was almost always away at one workshop or another, working as a facilitator for an HIV/AIDS education project in Tanga, the tutor education programme in Morogoro, and the Education II project which ran training in Mbeya and Butimba.<sup>48</sup> Even the tutor who was most often present commented:

Most of the time we are not around, last term I was out for almost 3 months giving training for PEDP.

(Mr Athmani, TTC tutor 20/1/05)

As a result of tutors' numerous other commitments, along with what I sensed from some tutors was a great reluctance to be observed, I found myself frequently arranging lesson observations with tutors and then arrive at the appointed time to find no sign of the tutor. As a result of this I made fewer observations with tutors than I had originally intended.

One of the tutors was happy to let me observe his generic education course although he was reluctant to let me observe his science course. His *Curriculum and Teaching* lesson is described in the extract below. The tutor spoke almost entirely in English except when giving simple instructions.

Year 1 lesson on Curriculum and teaching methods  
Tues 19<sup>th</sup> October 2004  
12pm

The tutor arrived at around five past twelve to find only a handful of the expected 195 trainees present so he sent them to call for others. When the room had filled up, the tutor started trying to get the class to count themselves- after three attempts he gave up. He then explained that he had been away last week for the assessment of primary school teachers. He also mentioned that other tutors were away running a workshop on participatory teaching.

At 12.37 the lesson proper started. The tutor gave a brief overview of the previous lesson, giving definitions of teaching method and teaching strategy.

---

<sup>48</sup> The numerous calls on tutors' time were symptomatic of a nationwide shortage of well-qualified personnel within the education and training sector. See Wedgwood 2005.

He then announced today's topic as "Criteria involved in selecting the method for teaching/learning" and wrote this title on the board. He gave the first criterion as "the level of the learner," asking the class if they agreed and saying "yes" when there was no response. After expounding on this point for a short while he asked the class to give other criteria. One trainee gave "subject matter" which the tutor wrote on the board. Another offered "The needs of the learner". The tutor seemed less happy with this and asked the class repeatedly "Is that true? Is that true?" then, without writing, went on to the next trainee who said "The availability of teaching and learning materials". He wrote it on the board. After asking for examples he then wrote "Objectives of the lesson" and impressed on the trainees the importance of lesson objectives and the importance of telling the class what the objectives of the lesson are, an activity that he had omitted to do himself.

The tutor continued in a similar way to create a list under a second title "Criteria for Selecting Teaching Strategies". He accepted the first two suggestions given and wrote them on the board. A girl then gave "Insistence on insightful learning," clearly reading it from her photocopied module.

"She is reading from the module without knowing!" The tutor accused her, and asked her to explain the words. The girl stayed silent. He then wrote her exact words on the board and gave his own explanation;

" 'Insistence on insightful' means learning that will be useful to others in the future- they are not forging". He then gave a long talk about forgery and avoiding plagiarism.

I found it difficult to make much sense of this lesson until I saw the module for the class. Many of the trainees in the class had photocopies of the module open during the period. Others had been writing notes from the board. What had been written on the board followed what was written in the module almost exactly, even down to the order of the bullet points. When trainees had made a contribution that matched what was written in the module, their answers had been accepted and written on the board. Answers that were apparently valid but were not listed in the module, such as "The needs of the learner", were not accepted. Few answers of this type were given since most of those who participated were giving answers from their modules. A pretence was maintained that the contributions were the trainees' own original ideas. When a girl failed at this pretence, by giving an item that she had to read directly, she was ridiculed by the tutor.



The module also made it clear why the tutor had talked about plagiarism when discussing the term “insistence on insightful learning”. He had based his explanation on what was written in the module, as shown in the extract below:

Criteria for Selecting Teaching Strategies

- The age and ability of the learner
- The learner’s motivation and interest
- Insistence on insightful learning- i.e *forging* relationships and principles and valuing these more than facts.

(TIE 1999:18, emphasis added)

He had misinterpreted the word ‘forging’ to mean plagiarism. Even at the level of tutors, comprehension of English is problematic and can lead to the perpetuation of misconceptions, as in the extract above. Here the tutor was able to use his position of authority to replicate a phrase that he did not understand while ridiculing the girl for doing the same thing. In ridiculing her he was able to reinforce his own authority.

Overall the lesson process seems to have involved the tutor writing the module material on the board and the trainees who couldn’t afford their own copies of the module copying it into their notes. Later in the lesson the tutor asked the class to list teaching and learning materials. When one of the trainees suggested *moduli*, the tutor reprimanded the whole class for their over-reliance on the modules saying: “You are using them like textbooks while they are not textbooks”. He held to the official line that they were notes for the tutor, ignoring the reality that trainees were able to buy photocopies from the library. He explicitly rejected the use of the module as a textbook while reinforcing its authority by replicating its contents as lesson notes.

The low attendance at the start of this lesson was not unusual for lessons at Zebaki and was indicative of a general apathetic attitude of trainees to attending classes. This lack of enthusiasm for attending class is very understandable in a context where there was very little certainty of the tutor attending and when the material covered on the occasions that the tutor did attend was almost an exact replica of what is in the modules that trainees already had access to. This apathy was also evident in trainees’ slowness to arrive at the start of the academic year. A month after the official start of

term in July 2005, there were still over a quarter of the second year trainees that had not yet reported.

There are a number of hidden curricular messages here that could contribute to trainees' pedagogic knowledge base. Firstly, they learned that for an instructor to attend their lessons has a very low priority when compared to other duties and demands on the instructor's time. It was normal practice for instructors to be absent without giving advance warning or setting work for their classes. Trainees also learned that the material contained in a set text, albeit an unofficial set text such as the *moduli*, defined what was acceptable knowledge. The validity of the trainees' answers was judged against the contents of the module rather than against experience. Trainees learned how to carry out a lesson that was, in form, participatory and yet in essence was entirely reproductive. There was also an implicit separation of theory and practice. The tutor told the trainees that it was important for a teacher to tell the learners what the lesson objectives are, but did not demonstrate this by doing it himself. Trainees learned how to prepare for a model lesson whilst being shown a different model. An implicit message here was that knowing what one should do is more important than doing it.

The relatively high value of theory over that of practice within the teacher training institution was also demonstrated by the limited experience that trainees were given in schools. Each year trainees at Zebaki were sent to schools for four weeks of teaching practice. This was less than the recommended duration (6-8 weeks). In the past, trainees had been allocated to schools throughout the whole region and in neighbouring regions. In 2005 it was decided that this would not be possible due to shortage of funds to cover the travel costs for trainees and for the tutors going to assess them.<sup>49</sup> Trainees were therefore sent only to schools within the local municipality and in the surrounding villages. As a result, the number of trainees at each school was quite large (5-12 trainees) and the number of periods that they could be allocated was small as they were all science trainees. Many of the trainees were only given one lower form class to teach, so had only 3 periods per week. In most

---

<sup>49</sup> This was a considerable cost as tutors could claim for 'per diems' if their visit involved an overnight stay. The amount set for a per diem represented around a week's wages. See Kerr 2006.

cases trainees did not teach during their first week as this was seen as a time for them to work out what they were teaching. In a significant number of schools the final week that the trainees were there had been set aside for mid-term tests. As a result, in some cases trainees only taught six 40 minute periods throughout the 4 week school visit.

During teaching practice there appeared to be very limited interaction between the trainees and the normal class teachers. There was no formal requirement for trainees to observe the class teachers during the first week and most trainees that I suggested this to seemed to find the idea quite novel. Once the trainees had taken on a class most teachers left them to it and did not enter the class with them or give them any feedback. I did encounter two cases where the normal teacher accompanied the trainee into the classroom. In both cases the trainees had been carrying out practical work in the laboratory and the teachers, who were both new to science teaching, had attended with the intention of learning from the trainees rather than training them.

I accompanied two tutors on their visits to assess the trainees on teaching practice. In order to allow the tutor to observe all trainees in a single visit, classes were taken off the timetable and in some cases the trainees were asked to teach for 40 minutes when they had prepared an 80 minute lesson plan. The trainees were debriefed as a group and very little individual feedback was given. Although 12% of the assessment marks should be based on the candidate's self assessment of the lesson, trainees were not asked to give their own opinion of the lesson during the debriefing. The tutors filled in assessment forms (see appendix 5) and gave the candidate a copy without the marks shown on it. The space provided for comment was very limited, with room for one or two words after each item on the marking criteria and a further two lines for general comment. In general the trainees received almost no feedback or guidance during their teaching practice, nor were they given opportunities to reflect on their own lessons or on the lessons of experienced teachers while they were at the schools. In almost all cases trainees were awarded a grade B for their teaching practice based on two lessons observed by tutors. The host schools had no input into the assessment process. As a result there was little incentive for persistent high

performance as the assessment only took place when tutors visited and grade B tended to be awarded for very good or very poor practice. Compared to the eight written examinations, the teaching practice was only a small part of the assessment. All diploma teacher-training colleges in Tanzania are linked to local secondary schools in order to provide further opportunities for trainees to teach or observe in schools, but according to informants and other research (Shayo 2003), these schools were never used for training purposes outside the block teaching practice period.

As described above, there was a vast gulf between the written curriculum and the curriculum in practice. The aspiration of what was written in the curriculum was far removed from the reality of the delivery of the teacher training. There was also a profound separation between theory and practice. The majority of the training process involved trainees learning educational theory condensed in the form of the *moduli*. Little opportunity was given to put the theory into practice and almost no opportunity was given for reflection on practice that could help trainees to link it to the theory. The targets of what should be known were so ambitious that there was little space within the curriculum for realistically developing the teaching skills that were alluded to.

#### **4.2.3. Pedagogic knowledge and content knowledge**

Most of the teachers in the sample had had some exposure to the concept of participatory teaching methodology. Of the 24 teachers, 10 had followed the post-2000 syllabus at diploma level. A further 5 had studied the diploma since 1997 when the term was introduced into the new curriculum. Most of the older teachers had received some form of in-service training in the last five years. Teachers at Chambuzi school had all attended a workshop by Zebaki tutors on co-operative teaching and learning approaches just two weeks before my visit. Others had attended SESS workshops that promoted activity based learning and discovery based learning. At Fadhili school the two teachers without teacher training were both familiar with the term 'participatory teaching methodology'. They told me that they had learned it from their colleagues. It appeared that theoretical knowledge about the

pedagogical models that were currently in vogue in official policy was fairly widespread within the teaching community at the research site.

A problem that teachers often faced in their attempts to implement participatory teaching methodology was that their limited content knowledge restricted their capacity to do so effectively. The new curriculum for teacher education had been introduced on the assumption that trainees would be entering the course with a solid foundation in their subject knowledge. Officers responsible for the writing and implementation of the teacher training curriculum at TIE (Massawe 27/6/05) and the Department of Teacher Education of the Ministry of Culture and Education (Kironde 22/6/05) claimed that since candidates had to have two principal passes at A' level it was assumed that they needed no further instruction in content. As far as one officer within the Department of Teacher Education was concerned, while it was true that many trainees did not have enough subject content knowledge, this needed to be addressed at school level rather than at the level of teacher training.

The tutors at the TTC were concerned that the change of syllabus from content to methods had been based on the false assumption that trainees would have a sound knowledge of O' level science.<sup>50</sup>

It is a false assumption that trainees know the subject content. They miss the content. We have recommended a return to academic/ content-based approach.  
(Tutor 17/1/05)

They teach very well but the wrong concepts. Trainees have a poor foundation in content. We are forced, despite teaching methods, to teach content, the methods are unsuccessful without the content.  
(Tutor 20/01/05)

Over half of the lessons (8/12) by trainees that I observed involved them transmitting or reinforcing scientific misconceptions. One trainee, for example, told his chemistry class that there was no way of finding the group or the period for a given element

---

<sup>50</sup> Rogan and Macdonald critique a similar situation in science teacher training in South Africa and assert that teachers need secure content knowledge before they are ready to deal with new teaching methodologies (Rogan and Macdonald 1985: 74).



based on its atomic number. Through our interview afterwards it emerged that he was unaware that the group and period of any element could be derived from the electronic structure, which can be derived from the atomic number. The stated objective in his lesson plan was that: "students should be able to relate electronic structure of atoms to their position on the periodic table." He had taken this objective directly from the syllabus without knowing that there was any relationship between electronic structure and periodicity. This concept is not only central to the understanding of the periodic table, but also, arguably, to most of inorganic chemistry. Another trainee taught a very theoretical lesson on the turning effect of a force. Following the lesson, when I tried to demonstrate the principle to him using a door, he would not believe me that I only needed a small force at the handle to oppose his large force applied near the hinge. It was clear that he had no understanding of the material he had just taught at a practical level. Other observations around the teacher training college revealed significant content knowledge gaps among trainees, such as a group who were unable to explain why metal boats float, even though this was a form I topic (Field notes 18/4/05).

Teachers also displayed major content knowledge gaps. As with the lessons by the trainees, around half (21/45) of the lessons observed included the teacher promoting one or more scientific misconceptions. The older, more experienced teachers revealed fewer misconceptions whereas all the male teachers who had started teaching since 2001 were observed to promote a misconception at least once during observed lessons. There are numerous possible explanations for this difference. It is arguable that the older teachers had stronger subject knowledge because their teacher training had included some science content, but it could also be the case that their subject knowledge had been enhanced during years of teaching and attending workshops. Another possibility is that the older teachers' subject knowledge was no more extensive than that of the younger teachers, but they had greater control over the direction of the lesson and were more adept at keeping classroom discourse within familiar territory. The younger teachers had followed the diploma syllabus that promoted participatory teaching methods (introduced in 1997, but reinforced in 2000). Teachers who were strong adopters of participatory teaching methodology

were more likely to reveal gaps in their content knowledge, not necessarily because their knowledge was any weaker, but because the teaching methodology exposed them to more questioning by students. Teachers using more traditional methodology were able to avoid revealing their weak knowledge by reproducing impressive sounding material from textbooks.

During the lessons that I observed, the female teachers revealed fewer misconceptions than the males. While observing the 5 female teachers (10 lesson observations) I only noticed one minor misconception being promoted by a teacher. The female trainee that I observed also taught without any content knowledge errors. Clearly these sample sizes are too small to draw any conclusions about gender differences in teaching science, but it could be the case that females tended to be better prepared for their lessons in terms of content knowledge or that they were more cautious about promoting ideas that differ significantly from those in the textbook.

Zebaki graduates entered the profession with extensive knowledge of pedagogical theory but weak content knowledge. The pre-2000 diploma curriculum had aimed to strengthen trainees' content knowledge, but did so by adding material that was beyond the O' level curriculum. This knowledge was therefore of limited use to the O' level teachers. The subject methods classes, introduced to replace the subject content course, provided a potential opportunity for trainees to develop their content knowledge while learning about ways of presenting the material. Unfortunately much of the time allocated to this in Zebaki TTC was lost either to the teaching of generic methodology or due to tutor absence.

#### **4.3. Trainees' images of teaching**

Aside from learning science, English and other academic subjects at school, potential teachers also learn about pedagogy from the examples of their own teachers. To access this knowledge I asked trainees at Zebaki to write about their best science teacher from when they were at school and to explain why they admired that teacher. Trainees were also asked to select from a list the three most important and three least

important attributes of a good teacher. On a later occasion, following their return from teaching practice, trainees were asked to discuss and write down metaphors for teachers, learning and teaching. Trainees occupy an intermediate space between being learners and teachers. Their images of teaching are therefore a mixture of their experiences as learners, their theoretical knowledge from the training and their experiences of teaching. The first two exercises were conducted prior to the trainees going on teaching practice and the first question specifically asked them to think about their experiences as learners. The findings need to be interpreted in the light of this.

#### **4.3.1. "My best science teacher"**

80 trainees were asked to write about their best science teacher from school and to explain why they thought that teacher was a good one. Within the 79 scripts received, there were 486 separate statements about the qualities of the selected models of best practice. The statements were grouped into categories as shown in table 4.3. The table also shows the most commonly mentioned characteristics within each category. It should be noted that many of the trainees were describing their most recent school learning experience which would have been at A' level. This may partly explain some of the differences between this data and that from the observations and interviews which relate to O' level science.

**Table 4.3: Most commonly mentioned characteristics in trainees' descriptions of 'My best science teacher'.**

Category	No. of statements within category	Most commonly mentioned characteristics	Number of times mentioned
Pedagogy	184	Conducted practicals/ demonstrations	32
		Used teaching aids	25
		Set regular tests	21
		Set exercises/ homework	20
		Used a range of teaching activities	14
		Gave verbal encouragement	14
		Used participatory teaching methodology	13
Outcomes	67	Students understood	26
		Students performed well	17
		Students liked the subject	17
Personal attributes	53	Good subject knowledge	19
Relationship with students	50	Encouraged/ open to questions	16
		Friendly/ close to students	15
		Helped individuals according to their level of understanding	13
General communication/ presentation skills	45	Provided good notes	9
		Interesting	7
		Clear	7
Professionalism	44	Gives help outside class	15
		Punctual	12
Subject presentation	43	Gave examples from environment	13
		Good syllabus coverage/ examination preparation	9

The most common characteristics mentioned referred to the pedagogy (184 statements), with 32 mentioning that their best teacher carried out practicals and demonstrations and 25 saying that their best science teacher had used teaching aids. Regular setting of homework exercises (20 mentions) and tests (21 mentions) were also seen as desirable attributes. This contrasts with the attitudes and practices of experienced teachers relating to homework, which was seen as being of limited value since students often copied each others work (see following chapter). 67 of the comments referred to the outcomes of teaching as reasons for why the teacher described was a good one. The most frequently mentioned positive outcome was that the students understood (26 mentions). It should be noted the meaning of what it is to

understand something may be culturally dependent and, as discussed in the following chapter, the ability to replicate information was often taken as evidence of understanding. Other frequently mentioned outcomes were that students liked the subject (17) and that they performed well in examinations (17). Out of the personal attributes described, good subject knowledge was the most frequently mentioned (19).

#### 4.3.2. The attributes of a good teacher

The same 80 trainees were then asked to select the 3 most and 3 least important attributes of a good teacher from a list of 17 attributes. 70 sets of answers (not all complete) were collected. The table below shows the number of times each attribute was mentioned as one of the three most important and as one of the three least important attributes.

**Table 4.4: Most and least important characteristics of a good teacher- as identified by trainees from a list**

	Most important	Least important
Explains clearly	44	6
Subject knowledge	43	1
Qualifications	26	6
Creative	19	7
Organised	14	6
Punctual	11	7
Hard working	11	7
Fairness	8	13
Interesting lessons	8	11
Discipline skills	7	8
Knows students	5	20
Writes good notes	5	16
Moral behaviour	3	9
Smartness of appearance	2	29
Friendliness	2	21
Authority	1	19
Many years experience	0	15
Total <sup>51</sup>	209	201

<sup>51</sup> A few students gave less than three characteristics as the most and/or least important, hence the totals are different and not necessarily divisible by three.



The ability to explain clearly was seen as an important characteristic by most trainees, but a close second was subject knowledge, selected as a key characteristic by over half (43/70) of the trainees that responded. Qualifications were also seen as an important attribute. The characteristic that trainees valued most (explains well, subject knowledge and qualifications) may be indicative of what they felt was most lacking in their own teachers. When characteristics are common among teachers, they might become taken-for-granted and not considered to be important. For example, in a context where all teachers have degrees, subject knowledge might not be considered to be an important quality for a teacher. Qualities are more likely to be valued if they are uncommon or unevenly distributed and where their absence becomes a limiting factor in the quality of teaching. Discipline skills were not considered to be particularly important among the trainees within this context, but this may indicate that trainees had had little experience of poorly disciplined classes where student behaviour becomes a major limitation on the quality of the teaching process.

Whilst friendliness was a characteristic that trainees often used to describe their best science teacher, knowing the students well and friendliness were considered to be among the least important characteristics from the list provided. This sort of contradiction highlights the limitations of quantitative data of this type. With regard to theories about the importance of authority within science classrooms, as discussed in chapter one, it is interesting to note that almost a third (19/70) of respondents gave 'authority' as one of the least important characteristics of a good teacher from the list and only one gave it as one of the most important characteristics.

#### **4.3.3. Metaphors for teachers, learners and teaching**

Zebaki trainees were asked to give metaphors for teachers, learners and the teaching-learning process. This was done in 4 sessions with around 50 trainees present at each session. The 'jug and mug' metaphor<sup>52</sup> was used to give an example of what a metaphor is. Most trainees were familiar with this from their diploma course (TIE

---

<sup>52</sup> Within this metaphor, teaching is likened to pouring information from a jug (teacher) into an empty mug (learner). The teacher is seen as the source of information, the learner as an empty vessel and learning as transfer of information.

1999: 17) where it is presented as an undesirable and outdated method of teaching. Although trainees were aware of it, no one was able to volunteer an explanation of why it was given as a metaphor for teaching, so I explained it to them before setting the exercise. Trainees worked in groups and wrote their metaphors on papers. 64 scripts with 111 metaphors for a teacher were collected from the trainees.

The most commonly occurring metaphor within the sample was with the teacher as a mother or parent and the student as a child (22 occurrences). Explanations given for this included:

The teacher is a parent because she/he ...  
... guides, counsels, punishes  
... is the source of knowledge  
... is the one responsible for keeping in constant the traditions and customs.

The learner is a child because she/he...  
...imitates.  
...receives advice.  
...obeys.

The next most common metaphor was the teacher as a mirror (12). Some explained this in terms of the learners learning through imitation while others explained it in terms of the teacher acting as a means of transfer of information to students:

...he reflects the ideas, views, knowledges to the students. (sic)

Another popular metaphor was the teacher as a bridge (9), connecting the students to the knowledge sources:

The teacher passes on information from the material she/he learned to the students.

A teacher is like a bridge because he connects two sides of literacy and illiteracy. Teaching/learning is like facilitating the transport from the ignorance to the cleverance. (sic)

There were also numerous metaphors involving cars with the teacher as the driver or the engine and the students as passengers (15)

A teacher is like a car because the teacher helps the students to move from ignorance to the knowledgeable.

A driver acts as a teacher who controls fuel which is like knowledge to the car as a learner.

Some of the resulting metaphors were highly original such as:

A teacher is like the International Monetary Fund (IMF) because IMF gives some assistance...and also gives some conditions.

The most common roles that emerged for the teacher were the teacher as nurturer (38), providing care and nutrition, and the teacher as a director (31), correcting and directing learners. The language of facilitation was used extensively in explaining metaphors for the teacher (23 explanations). In many cases the teacher's role was seen as facilitating the learner on their journey from ignorance to knowledge. However, as can be seen from the quotes above, the language of transfer of knowledge was also common (27 explanations) and 3 of the scripts even gave the 'jug and mug' metaphor. Many of the scripts gave explanations that spoke both of the facilitation and knowledge transfer. The metaphors indicate that many trainees had accepted the concept that the teacher is a facilitator of learning, but knowledge was seen as a transferable good or a reachable location. Learning was seen as attaining knowledge and good moral behaviour. With the exception of one script that gave a metaphor of a sports coach to describe a teacher, there was very little mention of development of skills as part of the learning process.

#### **4.4. Teachers' experiential knowledge**

On graduation from college, new teachers were assigned their first teaching placements by the government. First appointments were often in rural community schools. Many of these schools were newly established and therefore had many vacancies as they expanded,<sup>53</sup> but even in established rural schools the staff retention tended to be low. Most teachers preferred to teach in urban areas where there were

---

<sup>53</sup> The research was conducted during a period of rapid secondary expansion and the majority of schools in the country at this time had been opened within the last 4 years so were still taking on extra classes.

better services, communications and opportunities for additional money making enterprises such as private tuition. As a result, teachers appointed to rural schools tended to apply for transfers as soon as they were able. Many of the teachers that I spoke to in the urban schools had already served their time in the rural areas before having had their requests to be transferred to urban schools granted. As a result, the rural schools tended to have very few experienced staff. This is illustrated by the teachers involved in this study (see table 4.1). Within this sample the teachers at urban schools (Alizeti, Batobato, Chambuzi) were generally older, more experienced and better qualified whereas the staff at rural schools (Dafina, Edeni and Fadhili) were younger with less experience.<sup>54</sup>

Out of the seven science teachers at Fadhili School, there was only one trained teacher that had been there for more than a year. The remaining six were all either on their first appointment or teaching there as unqualified volunteers. These new teachers were all starting their profession in a situation where there was almost no professional support or experience base to learn from. The remoteness of the school made communication with teachers at other schools very difficult. Even in schools where there were experienced staff, there were no official induction processes for new teachers.

In large schools, each year group was taught by one teacher for each subject. This practice limited the opportunity for teachers to collaborate in their planning, teaching and assessment of classes. In one school, teachers in some departments had started to introduce 'team teaching' where the regular class teacher would invite another teacher to take their class for a lesson or a topic, but in general there were few opportunities for teachers to collaboratively build up a communal body of knowledge of how to teach science within the context of the school.

---

<sup>54</sup> See Wedgwood (2005) for further discussion on rural-urban differences in education.

## **4.5. Books**

### **4.5.1. Published texts**

After observing lessons, I would ask teachers where they had got their information from for the lesson. Most teachers responded to this by listing the books that they had referred to. Even for those with money, the range of textbooks available in Tanzania was very limited. Until 1991 the production of textbooks in Tanzania had been the sole domain of TIE. TIE continued to write textbooks throughout the 1990s and their books remained the most widely used in this study due to their availability and their close following of the syllabus. There was little need of an index with these books as teachers and students simply went through them linearly rather than using them to find out specific things. Out of the TIE science texts books, only the biology books had an index.

Texts published outside Tanzania were also used in secondary school science, but the range of titles used and available in shops was relatively narrow (see appendix 6). Some schools did have class sets of these texts, often received as a donation to the school through externally funded projects like the SESS project. Very few Tanzanians were able to afford to buy textbooks new and, as a result of the limited market, shops selling them could only be found in the regional capitals. Some of the students had private copies, but these had generally originated from another school rather than a shop. The publishing market has now been opened up and locally produced alternatives to the TIE books have become available for primary science and some new secondary science texts, written for East African curricula, were beginning to appear. One area that appeared to be booming was booklets of examination style questions with worked model answers.

Whilst the TIE books for biology and physics were used extensively, some teachers commented that they found them too summarised and preferred to use the imported books. The TIE chemistry book (TIE 1995) is largely activity based, giving instructions for carrying out experiments and then providing questions based on the observations made. As a result it was of little use to students or teachers in schools



where practical work was not carried out on a regular basis. Of the TIE science books, the chemistry books were the least frequently referred to or observed in use. The choice of which book the students had access to was generally beyond the control of the teacher as it simply depended on the school's resources.

The TIE books were locally relevant to the extent that they closely followed the syllabus, but there was little evidence of efforts to make them relevant to the wider Tanzanian context. The organisms in the biology book were generally ones found in Tanzania, as in the syllabus. However, there is little locally specific content in the Chemistry or Physics books. For example, the chapter on the extraction of metals in *Secondary School Chemistry book 2* (TIE 1995) gives no information on the occurrence of metal ores in Tanzania or of local methods of extraction. The section on fermentation mentions wine, whisky and brandy but none of the brews local to Tanzania.

Trainees at Zebaki generally had access to a wider range of texts than teachers had in school. Zebaki TTC library had a good selection of science textbooks and books on pedagogy, but most of the trainees' interest was contained on the reserve shelf. The reserve literature was mostly produced by TIE and included syllabi, modules, and science textbooks for forms I-IV. There were also past papers from NECTA. Most of this material was heavily thumbed. The main shelves contained a wide range of international science textbooks, beyond the ones listed in appendix 6, but these generally remained on the shelves with their spines unbroken. The librarian had ordered some books about methodology in science, hoping that they would be useful, but they had never been borrowed.<sup>55</sup>

For the diploma course the *moduli* were treated a set text, as confirmed through informal conversations with the librarian and observations of what the trainees read. These were unpublished, but the library would photocopy them for any trainee able

---

<sup>55</sup> The library had, for example, *Learning and Teaching in School Science* (Bently and Watts 1989) and *New UNESCO Source Book for Science Teaching* (UNESCO 1973). Neither appeared to have been extensively read.

to pay, and copies were in general circulation. Books written about education that did not specifically follow the diploma syllabus were not extensively used. The *moduli* were also an important knowledge source for the tutors who had been issued with them. Researching ideas from a wide variety of sources was not part of the culture of education. In the lesson on *Curriculum and Teaching*, from which the extract above was taken, the tutor criticised the trainees for relying on the module as their sole source of information and yet it was apparent that he was doing likewise. According to the librarian, only one of the tutors regularly used books from the library. The tutors did sometimes set trainees group exercises of researching and presenting on a topic. But in the plenary sessions that I observed, it was apparent that all groups had taken their information from the modules or the TIE textbooks.

TIE has not written any new science textbooks since 1995, but a dependency culture has become established so that teachers did not feel confident using other textbooks even when they were available. Topics added to the syllabus in 1997 are missing from the textbooks and in many schools these topics were neglected. Other topics, such as classification in biology, have been extensively reduced in the syllabus, but were still taught in the high level of detail found in the textbook. Teachers justified this by explaining that exam questions are still set that require the detailed level of information. There was great concern among teachers, trainees and science tutors that there had been no new textbook published to accompany the combined *Physics with Chemistry* syllabus that was introduced in 2005. Even though this syllabus, to a large extent, alternated topics taken from the 1997 syllabi for chemistry and for physics, teachers did not feel confident to extract the relevant sections from the old textbooks.

One reason why teachers and learners may have found it difficult to use other textbooks was that their English skills were insufficient for them to comprehend unfamiliar textbooks well enough to select the material that was relevant to the syllabus (see chapter 2). The text-based knowledge sources science teachers drew upon appeared to be restricted to a locally specific set. This set was one that was known to provide information needed to pass examinations. Teachers and students

lacked confidence that 'untested' texts would provide the answers required in the examination. Teachers and tutors would not accept answers that were beyond the set text. This validated the set text and reduced the worth of knowledge from other sources. The approved texts appeared to have gained almost scriptural authority so that new texts that presented things in a different way were not highly valued or frequently used. The set of approved texts was highly local in the sense that local knowledge was needed to know which texts were considered valid, and yet it consisted of texts that were mostly bereft of content relevant to Tanzanian life.

#### **4.5.2. The hidden text book**

During lesson observations it was notable that very few students had textbooks with them, even in schools where there was a relatively good supply. Many students had exercise books full of notes open on their desks. These were not the books that they used for their own class work and they were frequently written in a different handwriting. When I asked about them I found that they had come from siblings or friends who had already completed secondary school. In some cases they had been copied from another student. Over 90% (49/53) of students that I asked during group interviews claimed to have used the notes of a sibling or friend.<sup>56</sup>

One reason given for using another student's notes was simply lack of access to textbooks. Even where textbooks were available, notes were often used in preference. When I asked a group of students which was more useful, a textbook or someone else's notes, one replied:

Just notes- the textbook is very complicated, the teacher must pass [through it] first. If the teacher can simplify it can be known.  
(Edeni Students' interview 8/3/5)

According to the students interviewed, these notes were passed from one student to another without charge, although there is anecdotal evidence some students sell their notes when they finish form IV (Mafumiko and Leliveld 2006: 14). The pedigree of the notes was simply based on word of mouth. If a teacher at a school was known to

---

<sup>56</sup> This practice is also noted by Vavrus (2003: 75) in her study in schooling in Kilimanjaro region. She considers it as a strategy developed to cope with the lack of textbooks.

be a good teacher then students from different classes and different schools would use the notes that he/she gave. What was remarkable about these texts was the apparent conformity across what appeared to be a wide variety of sources (see section 5.1.1). A possible explanation for this conformity is that a set of notes has been multiplied from a single source as it has been passed down from teacher to student over several generations.

While working as a teacher in Tanzania I was told that many teachers simply used their own notes from when they were at school and transcribed these onto the board for their students to copy. These notes were known as 'yellow pages' because they had become yellow with age and use. When I asked teachers whether they had ever used their notes from their own education, they tended to deny this vigorously. The strength of their response indicated that this was a practice that was frowned upon. My inquiries about the use of 'yellow pages' tended to be met with denial although one tutor conceded that this had been common practice in the past due to shortage of textbooks. According to a lecturer on ethics of education at the University of Dar es Salaam, and former high school teacher (Anangisye 1/2/06 personal communication), the use of yellow pages is still common practice at University and High school level.

The hidden textbook embodied in hand written notebooks appeared to be relied on as a knowledge source for students much more than the published textbooks, and in some cases was considered to have greater authority. It has been shaped by teachers experienced in knowing what examiners test for and has gained status through replication. It has also been more responsive to changes in the syllabus than the TIE textbooks that have not been re-edited since they were first published in 1995. It was a major component of the knowledge base of secondary science education for the students in this study.

#### **4.6. Students as a knowledge source**

Proponents of participatory methodology, including teachers and tutors, frequently informed me that the teacher should not be seen as the only source of knowledge in the classroom. Trainees at Zebaki were told by tutors that students should not expect the teacher to act as the only source of knowledge, but that they should also expect to contribute.

Modern teaching does not encourage lecturing. Now we are at a transition period when the student should be doing more than the teacher, so don't be surprised when I ask you questions. You may think the tutor does not know, but sometimes I may not. The students are the ones who know.  
(Zebaki TTC Tutor, Biology methods class 9/2/05)

Many teachers espoused the idea that their role was one of a facilitator, there to draw out students' knowledge, rather than being the main knowledge source themselves.

We are advised that not to think that we are experts, we must think that even students, they have got some ideas.  
(Mr Kivelege 2/3/05)

Also, I as a teacher am not supposed to do everything. My work is just leading the discussion as a chair-person, they are the ones who are to solve the questions, I am just guiding the discussion so not talking much than the students. Just helping them.  
(Mr Yusuph 2/2/05)

You know we are just there for sharing ideas, there's no-one who knows more than others. I'm just there just for leading them. Just to reach a definition.  
(Mr Kigula 26/1/05)

During the feedback sessions, the vast majority of teachers agreed with the statement that: "students are an important source of knowledge in the classroom".

Although teachers had generally accepted the concept that students brought knowledge to the lesson with them, the type of knowledge that students were asked to contribute to lessons was generally textbook knowledge as opposed to experiential knowledge. When I discussed with teachers where their students got their knowledge



from they generally mentioned primary education, reference books, textbooks and other students who had studied the material before them.<sup>57</sup> Some teachers had a deliberate policy of telling their class the topic to be studied in advance so that they could read up on the subject or ask other students for help.

Always I'm used to give them topics before starting, so may be say "next week we will be starting this topic so go and ask your fellow brothers or sisters to give you introduction on this topic." Then when we are in the class almost everyone they should participate.

(Mr Kiswaga, 27/7/05)

After one lesson in which the students had been particularly responsive the teacher informed me that he had taught the parallel stream the day before and they had failed to respond to his questions. The class I had just observed had already got the notes from their colleagues and hence were able to provide the answers. When I asked him how he would teach the lesson differently if the class had not been primed in this way, he struggled to answer and simply said that it would be difficult to get much class participation in that situation (Mr Msusa, 26/7/5). I never heard a teacher assigning reading or research to a class, but many teachers considered preparation reading a prerequisite for students to be able to participate in classroom discussions. The model of learning that many teachers promoted was not dissimilar to that which is practised in seminar based courses in Western Universities where students are expected to read an assigned set of literature before each seminar. However, the Tanzanian students were not given any direction over what to read and often the only available source was other students' notes.

There were very few cases where students were given questions that attempted to access knowledge other than textbook knowledge. Trainees had difficulty in constructing questions that could access students' experiential knowledge. In a lesson at Zebaki on how to introduce chemistry as a subject at secondary school, trainees suggested the following 'opener' questions:

Define chemistry

---

<sup>57</sup> Tabulawa reports similar findings in Botswana. Teachers and students saw the sources of school knowledge as the teachers and the textbook. The knowledge was considered to be external to the students (Tabulawa 1998: 261)



Where do you find chemistry?  
Mention things which are the results of chemistry.  
Why do we study chemistry?  
How is chemistry applied in our daily life?  
What is chemistry dealing with?  
(Chemistry methods class, Zebaki TTC, 15/08/05)

After considerable prompting by the tutor, one trainee suggested asking: "What will happen if you burn a piece of paper?" But most of the subsequent questions asked required knowledge of textbook chemistry rather than out of school experience. As illustrated in the extract of the lesson on Curriculum and Teaching methods class above, and questions on definitions discussed in the next chapter, some educators were not willing to accept answers from students that did not correlate with what was written in the textbook.

Although the accepted text for science tended to be largely abstract there were numerous cases where 'everyday' applications were mentioned. Some of these 'everyday' applications were beyond the experience of rural Tanzanians and this made it difficult for teachers to relate learning to students' lives at the same time as equipping them for potential examination questions. Consider the following extract from a lesson where the teacher wanted to teach about the applications of thermal conductors and insulators:

Teacher: What about the kettle- it's made of what? The handle is made of what?  
Class: What is kettle?  
Teacher: You know frying pan [repeats in Kiswahili] is made of what?  
Class: iron  
Teacher: and what about the handle?  
[long pause and some muttering]  
Boy: Plastic  
Teacher: Why is it made of a different material? What would happen if the handle was made of the same material?  
Boy: [inaudible attempt]  
Teacher: [explains in Kiswahili]  
(Mr Kiswaga, physics lesson observation, Fadhili School 27/7/05)

Mr Kiswaga wanted the students to consider the use of thermal insulators as handles for cooking vessels. Unfortunately for Mr Kiswaga almost all cooking in Tanzania is

done in aluminium pans without handles. The class did not know what a kettle was. Frying pans are used, but most are made by local tinsmiths and have metal handles. One boy guessed plastic, and this allowed the teacher to continue with his discussion. But for most of the class this would not have been helpful in linking their experience with the concept of insulators. The teacher could have referred to the scraps of paper or material that are generally used in Tanzania to lift hot containers. But this sort of application is of low technological cachet and would not be referred to in textbooks, even those written in Tanzania.

Many areas of science cannot be easily related to Tanzanian everyday life. Within a constructivist teaching paradigm the teacher would be expected to provide experiences within the classroom from which students can derive knowledge for themselves through observations (see chapter one). A major role of practical work within school science within this paradigm is to create opportunities for students to derive their scientific knowledge from observation rather than from textbooks. The teachers in this study focused more on the skills training role of practical work than its role as a source of personal discovery of scientific knowledge. Teachers frequently told me that they left the practical work until the end of the topic. One teacher teaching about sulphuric acid gave questions to his class about its appearance and chemical properties, but he expected his class to derive this information from books without them ever having seen the substance, despite it being available (Mr Mtewa, 14/4/05). Another teacher told his class about conifers, using a published wall chart. It was only after telling his class about the features of a conifer that he took them outside to observe one (Mr Abas, 26/07/05). In both these cases the source of knowledge was the published material and observation of the objects involved was supplementary to knowing the facts. A further exploration of the attitudes to practical work is given in the following chapter.

Even when teachers went to efforts to carry out practical work, it was evident that the 'approved' observations were considered more 'real' than the actual observations. In a lesson on food tests the teacher had written the various tests on the board in tabular form. He had left gaps in the column under 'reagents' so that the students could

participate by informing him what the reagents were. This was something they could only know from being told or having read. The column for observations had already been filled in by the teacher, even though this was knowledge that the students could have derived from observation. During one test he asked the class what colour the mixture had turned. When the class responded 'orange', he corrected them and told them it was brick red, as in the textbook, even though the precipitate was clearly orange at that stage (Mr John, 13/4/05).<sup>58</sup> Another example where textbook representation of reality was considered more valid than reality was in drawings of apparatus diagrams. According to the teacher, the cross section of the conical flask was more acceptable than a perspective drawing because "it looks more like the real thing" (Miss Hadija, 27/1/05). Teachers' perceptions were moulded by their textbook knowledge.

Teachers' dependence on approved textbook knowledge and suspicion of other knowledge sources were highlighted by an incident in the biology department at Chambuzi School. Mr Mfikwa (Mr M.) had gone to the head of Biology, Mrs Chambulila (Mrs C.), to ask for sources of information on a new topic in the form I syllabus, *good manners and personal hygiene*. Mr Mfikwa also asked me (RW) as I was present and he knew that I had taught biology in the past. We went through the books available and found relevant sections in several books, but under different titles. These did not satisfy Mr Mfikwa.

Mrs C. : Maybe there is a book for this that they have sent to other schools, but not to here.

Mr M. : [points out the topics of hygiene and waste disposal from the syllabus]. Where are we to get this from? [laughs]

RW: Do you think that the students know something? Maybe you could use discussion?

Mrs C. : Discussion with form I? No! They can't do it. Maybe they know something from primary school, but they learned it in Kiswahili.

RW : Can you use knowledge from around, from what you know?

Mr M. : No, I might teach something out of topic.

RW : Why do you think they included these things?

---

<sup>58</sup> As Driver (1983) argues, 'discovery' science in schools is flawed as it fails to recognise that teachers' observations are influenced by their scientific knowledge. Therefore it is wrong to expect students to make the same observations as a trained scientist would.

Mr M. : I don't know, maybe they have shifted it from domestic science, now that they have dropped domestic science, maybe they are just including some of these general things.

Mrs C. : Yes, I told you, you need to go to school \_\_\_\_, they used to teach domestic science, they will have the books.

(Field notes, Chambuzi School, 14/4/05)

The next day I brought a book I had found in Zebaki TTC library that was produced by MoEC with the United Nations Population Fund (UNFPA) on family life education. It had a few pages entitled *Personal Hygiene* and also a section on good manners. This made Mr Mfikwa very happy.

Mrs Chambulila assumed that if the material was in the syllabus then it must be explicitly mentioned in a textbook issued to schools. Neither teacher was happy to use knowledge from books that were not published by MoEC or TIE and that did not lay out the information in the sequence that it was presented in the syllabus. My suggestion of using discussion was rejected on the grounds that if they knew anything on the subject it would have been taught to them in Kiswahili. Knowledge that they may have from home was not mentioned, although the same reservation over language would apply. Mr Mfikwa was not confident enough in his own knowledge because he feared that he might teach something that was 'out of topic', implying that he might deviate from what was in the approved set text and hence what would be examined. I asked him about the rationale for the inclusion of this topic to see if he felt that the knowledge had utility beyond gaining qualifications, but his answer showed that he saw it as part of the body of knowledge that needs to be learned as part of secondary schooling. He did not question its presence in the curriculum, almost as if he assumed the curriculum to be a constant, pre-specified body of knowledge.

Mr Mfikwa's fear of going 'out of topic' was symptomatic of a pedagogical culture that sought uniformity in classroom learning on a national scale. During group interviews I asked students what they thought if a teacher came to a class without any notes or books. Some said that this gave them confidence that the teacher knew his/her subject knowledge, but others expressed concern that the teacher might stray from a set script and teach different classes different material (Batobato students

4/2/5). The syllabus is generally followed in a totally linear way. It not only provides the order in which topics are taught, it also gives the teaching and learning strategies and resources to be employed. Theoretically all classes of one form throughout Tanzania should be studying the same topic at the same time with the teacher using the same methods. What was clear from students and teachers was that there was a strong belief that the same knowledge should be transferred to all classes.<sup>59</sup>

The predominant pedagogical culture observed was one in which the knowledge explored in classrooms was considered to be a clearly defined body of uncontested and incontestable knowledge embodied in a set of published textbooks and unpublished lesson notes (or modules in the case of the diploma curriculum). A factor that may have supported and sustained this culture was that teachers' own subject knowledge was fragile, so that they lacked the confidence to select and judge the validity of knowledge from untested sources. As an officer at the Ministry of Education and Culture put it:

We need to address the quality of teachers. There is this 'book syndrome'. If you don't have enough knowledge you will die holding a book. Teachers who are weak in their subject knowledge cling to the exact words written in a book.

(Swai 27/6/05)

However, it is not simply a matter of low qualifications of teachers. Mrs Chambulila was a degree holder, but from her lessons and conversations with her it was apparent she considered the knowledge to be discussed in biology lessons to be that which was contained in science books. Like all other teachers at the feedback sessions, she did not comment when I omitted experience from a list of students' knowledge sources. The adherence to textbook knowledge appeared to be an attitude to school science that had become culturally rooted within the education system. The roots and development of this culture are explored further in chapter six.

---

<sup>59</sup> Rowell (1995) also noted this belief among Namibian teachers attending teacher education courses.



#### **4.7. The separation of theory and practice**

Tanzania has attempted to address the problem of the persistence of transmission teaching in schools by increasing the pedagogic content of the teacher-training curriculum. The new curriculum proposes that trainees learn through interactive methods, predominantly through group discussion and sharing of ideas. The teaching methods promoted are participatory, but are also resource intensive. The aspirations of the curriculum were far removed from the realities of Zebaki teacher training college. Contact time was much lower than intended and training tended to be reproductive even when it was participatory. The curriculum did not acknowledge or seek to address the problem of trainees' fragile subject knowledge. The subject methods classes provided an opportunity for trainees to strengthen their subject knowledge while learning how to present it, but trainees still demonstrated major knowledge gaps in their teaching.

Even at the level of the official curriculum, the balance between theory and practice in teacher training was weighted heavily towards theory. The actual amount of time that trainees got to learn through practice was far less than the official quota. There were virtually no opportunities to observe and reflect on the practice of experienced teachers. While financial constraints contributed to the limited opportunities for trainees to learn through experience, it may also be symptomatic of a pedagogical culture that values learning theory from books over learning from experience. This was reflected in the assessment of trainees, which was dominated by paper based examinations.

A similar trend could be seen within science classrooms. Teachers drew their knowledge from textbooks and expected their students to do likewise. Teachers encouraged students to participate in classroom discussions, but the primary source of knowledge was seen as the textbook. The curriculum was seen as a body of knowledge that was relatively discrete, uncontested and unchanging. Teachers were very reliant on texts that were known to follow the curriculum and had limited access to a wider range of texts due to language and resource constraints. They lacked

confidence that knowledge drawn from other sources would conform to the curriculum. Within this conception of the curriculum, there was little room for experiential knowledge and it went virtually unrecognised. Teachers acknowledged the importance of observation in learning science, but the act of observation was not seen as a valid source of knowledge.

For most of the informants in this study, learning pedagogy and learning science were both seen as processes that involved the accumulation of a body of codified knowledge as specified by the syllabi. Experiential knowledge was not highly valued and was rarely related to theory. This culture has been largely influenced by the examination system, which is explored in the following chapter. However, the examination system itself is a product of a wider set of cultural influences that are discussed in chapter six.



## 5. Classroom Culture and Pedagogy

This chapter discusses pedagogical culture in Tanzania by considering how teachers managed the way in which students acquired new knowledge about science. It first looks at how the knowledge was organised or “packaged” for learning. As discussed in the previous chapter, the scientific knowledge in the schools visited was drawn from a relatively discrete and limited set of sources. This isolated knowledge base has contributed towards a pedagogical culture that assigned concise definitions to terms within science education and conserved these definitions through pedagogical practice. This approach to scientific knowledge was also applied to pedagogic knowledge in teacher training. Defining technical terms and allocating concepts to categories are common heuristics in many knowledge areas, but the observations from this research indicate that the educators assigned formal definitions to terms that would not be considered as technical and needing concise definitions within a British context. It was also found that knowing the definition was seen as a necessary precursor to learning about a phenomenon, and the ability to deliver the definition orally was taken as evidence of understanding. Over-lapping of concepts was often not tolerated and phenomena tended to be assigned into discrete formal categories.

Teachers used the discourse of “participatory teaching methodology” to explain their actions in the classroom. Methods that encouraged students’ oral participation in lessons were common. In only a minority of the observed lessons could the predominant method be described as lecturing. This chapter looks at the range of different strategies and methods that teachers used to involve their students in classroom discourse. Teachers generally sought ideas from their students and tried to avoid telling students that they were wrong, but their narrow knowledge base meant that they were not able to accept or develop pupils’ contributions if they did not fit closely to the textbook knowledge. In response to this, students learned to give answers that corresponded closely to the text, and the form and authority of the text were conserved. However, this culture of replication did not dominate entirely. Given appropriate encouragement, students were frequently observed to raise insightful questions, motivated out of curiosity rather than a desire to stockpile knowledge for passing examinations. Many teachers were able to establish an open

classroom atmosphere in which students could formulate their own ideas. Two effective strategies described are the instigation of competition and the presentation of group research conducted outside the classroom. Unfortunately the teachers' narrow knowledge base limited the scope of these more open discussions and sometimes led to the propagation of misconceptions.

Students' participation in lessons beyond oral contributions was limited and this chapter looks at possible explanations for this. As well as the attitude to experiential learning discussed in chapter four, this chapter considers how teachers often saw experimental aspects of the science curriculum as additional to rather than integrated with the theoretical aspects. The type of practical work that was assessed in the examinations was very resource intensive and this helped to promote the belief that practical science could only be carried out in well-appointed laboratories. Knowledge of how to conduct practicals beyond those tested for in the examinations was often lacking within the school science departments that were researched. The number of written exercises set for students was also limited. One possible explanation for this is that teachers did not see problem solving and practice as a process that reinforced learning, but used it almost entirely for assessment purposes.

Two major influences on pedagogy were the choice of medium of instruction and the assessment system. This chapter looks at the influences of both while acknowledging that they are in themselves reflections of cultural attitudes towards the curriculum. Both of these influences can be seen as antagonistic towards the development of more participatory teaching and learning in schools.



## 5.1. The organisation of knowledge

### 5.1.1. The importance of definitions

Most teachers and trainees would introduce a new topic or sub-topic to a class by asking for definitions of the key terms involved.<sup>60</sup> Definitions were asked for everyday terms such as 'food' as well as for technological terms such as 'transformer'. The following examples of lesson openings were typical:

Teacher: Today we are doing something known as flame. [Writes FLAME]  
What is flame?

Girl: Flame is a ....[inaudible]

Teacher: yes, good try

Boy: Flame is a burning gas which gives out heat and light.  
(Lesson observation, Miss Zuwena, trainee teacher, 4/3/05)

Teacher: Who can define reproduction?

Girl: is the ability of living things to produce offspring.

Teacher: another one?

Boy: is the ability of living things to produce new individuals which  
resemble their own kind.

[Teacher writes boy's definition]

(Mr Mdemu, biology lesson observation, 27/7/05)

When I asked teachers why they had started with the definition, some of them pointed me towards the syllabus.

Obviously the definition should come first... now even in our syllabus you see that the first point should be 'What is biology?'  
(Mr Mwalongo, 25/7/06)

The science syllabi that were in use until 2004 all had as their first objective "explain the meaning of chemistry/biology/physics" (MoEC 1996a,b,c). The 2005 form I syllabus for *Physics with Chemistry* also has as its first objective that students should be able to explain the concept of Physics with Chemistry (MoEC 2005a). In the new Biology form I syllabus the first objective given in every topic is to define or give the meaning of one or more terms (MoEC 2005b).

---

<sup>60</sup> This has been noted as common practice in other parts of Tanzania. See Stambach (2000:116) and Frommer and Weingardt (2003).

Definitions were also a dominant feature of students' notes, especially at the start of a topic. For example, in the first two pages of a student's notes on the topic of "health" there were definitions of health, disease, immunity (natural and passive), immunisation, vaccine, vaccination, infectious and non-communicable diseases. There was very little discussion of any of these concepts beyond a concise definition. When the teacher did not give a written definition of a key term, students would often request one. Dictionaries of science<sup>61</sup> giving alphabetically ordered definitions were very popular among those who could afford to buy books and were among the more widely available texts.

When I discussed with teachers the importance of students knowing definitions, it emerged that being able to recite a concise definition was seen as evidence that students had 'got the concept' or understood it. Without the definition it was feared that students would not understand the key term and hence become confused by the ensuing discussion.

Now after being defined it means that they are having a concept on living things, now when grouping it means that they will be grouping while they know that all are living things but do differ to some extent.  
(Mr Mwalongo, 25/7/06)

Constructing the definition of the transformer... I thought it is important because, going on while others, they don't know what it is you are dealing about, I think is not good. Therefore I thought it is good that everyone has got the concept 'what is it?', then the nature of it.  
(Mr Chuma, 28/7/06)

The syllabi suggest that definitions should be derived through student discussions led by the teacher. The extract below shows how a teacher introduced the topic of growth and development through group discussions on the definitions of these terms.

Students have been put into groups to discuss the following question:  
*What do you understand by the following terms?*  
*growth*  
*development*

---

<sup>61</sup> See, for examples, Martin and Hine (2000), Isaacs (2000).

The teacher starts the plenary session and asks the first group to give their answer. A girl stands up and reads:

“Growth is the permanent or invisible quantitative increase in height, size, volume, number of cells and dry mass of protoplasm by the synthesis of proteins.”

The second group then reads out and writes up their definition on the board:

“Growth is the permanent or irreversible quantitative increase in size, height, volume, number of cells and dry mass of protoplasm by the synthesis of proteins.”

... and so on round the 6 groups. All of the definitions are virtually identical. The teacher writes:

Growth is the characteristic of living organisms which refer to the permanent or irreversible quantitative change or increase of size, volume or height and dry mass of protoplasm due to synthesis of protein.

The teacher then says, “Is there anything that you do not understand there? [Silence] Good! So all groups have the same. So here to me it shows that you have understood the concept.”

(Mrs Chambulila, lesson observation 14/4/05)

The teacher interpreted the replication of a definition of which she approved as evidence that the students understood the concept of growth. The fact that all groups produced the same definition, with the exception of small differences that may have been due to transcription errors, indicates that the definitions originated from the same source. When I asked students where they had got their knowledge from they pointed to the textbook, but this did not include this set of wording. When I asked the teacher where she thought her students got their knowledge from, she answered:

They are very clever students. They borrow exercise books from their seniors and read them in advance of the lesson and we do not hinder them.

(Mrs Chambulila, interview 12/4/5)

While neither the syllabus nor the textbook gave definitions of the terms, the ‘hidden textbook’ consisting of old notes, did (see chapter four). What was remarkable about this unofficial text was the uniformity of the wordings of the definitions between different sources.

When I worked as a teacher in Tanzania I was frequently being asked for concise definitions of terms that I had never thought to define. I would generally compose a definition of my own, making every attempt to use the simplest language possible. When I marked the end of year examinations I was disappointed to find that most students responded to questions by simply giving definitions for key words within the question. What confused me was that the whole class tended to give almost identical definitions. The definitions tended to use very complex language and, although some forms were incomprehensible due to being poorly memorised, they were recognisable as attempts to give the same verbatim phrase. I knew that the source of these answers was neither the textbook, nor the definitions that I had given in class. With the hindsight of this research I now realise that these definitions came from the hidden textbook circulating in the form of hand copied notes. This hidden text had more authority than the notes that I gave, as the definitions were couched in more complex and impressive language. It was also used in preference to the textbook as it was structured in a form convenient for using to answer common examination questions.

In a chemistry methods class at Zebaki, the tutor guided the trainees to show how they could introduce chemistry as a subject by deriving a definition of chemistry through questions and answers. While this exercise appeared to be fairly open, with the opportunity to compose any one of an infinite range of possible definitions, it was clear that the tutor was aiming for one specific set of wording. The trainees had already suggested a wide range of questions for the introduction of the subject, but none of these appeared to satisfy the tutor (see chapter four section 4.6) and he gave them some further guidance:

In the definition we have 'matter' and 'its changes' which means that you have to give them questions to guide them to 'matter' and also to the changes that happen in it.

(Tutor, chemistry methods class, Zebaki TTC, 16/8/5)

Teachers would often collect several versions of a definition before writing one on the board, but the process was one of rejecting 'incorrect' definitions and selecting

the approved version, rather than developing an optimal definition from the suggestions provided. Definitions that deviated in form from the accepted version were in some cases ridiculed or, as in the extract below, simply passed over. As discussed below, when a teacher passed over a student's answer it implied that the answer was unsatisfactory.

Teacher: Combination reaction. What happens in a reaction of this type?

Girl: Combination reaction is the reaction which takes place when the substances combine to form one substance.

Teacher: Another one?

Boy: Combination reaction is the type of reaction whereby two elements combine to form a single compound.

Teacher: Good. [writes: Combination reaction is the type of reaction whereby two substances combine to form a single substance.]

(Mr Msusa, chemistry lesson, 26/7/05)

Although the teacher did not explicitly ask the students to give a definition, they answered his question by stating one. The written definition that the teacher gave was technically closer to the girl's definition, both using the term 'substances', yet the girl's definition was passed over without comment and the boy's definition was praised. The boy's definition may have been more acceptable because it conformed to the word order and rhythm of the answer that the teacher was looking for. Teachers and trainees appeared to privilege the wording and meter of the definition over the meaning, as illustrated by a trainee who corrected a definition supplied by a student as follows:

Teacher: Who can try to define periodic table?

Girl: Periodic table is an arrangement of elements in increasing atomic number.

Teacher: Periodic table is an arrangement of an element *according to* the increasing atomic number. Say "according to".

(Mr Rahim, trainee teacher, chemistry lesson 08/03/05)

Definitions within science education were treated as immutable phrases that were frequently incomprehensible to those who quoted and transcribed them. The concise definition was given at the start of the topic, providing a key for further elaboration. The ability to quote these liturgical phrases was taken as satisfactory evidence that



students had understood the concept. It was as if the words of the definition encapsulated the concept and alteration of the words would corrupt the concept itself. This aspect of pedagogic culture was not simply confined to science. The modules and lessons at the teacher training college were dominated by definitions for terms such as *textbook*, *syllabus* and *demonstration*. The dominance of the definition appeared to be embedded deep within the pedagogic culture.

This resonates with Horton's (1967) observations of the magical attitude to words in a traditional African worldview. He claims that in an African world-view, words are bound to reality. Scribner and Cole (1981) also describe African communities where there is no separation of the word from the concept. As discussed in chapter one, literacy may be a prerequisite for metalinguistic cognition, and in recently literate societies the word and the concept may still be tightly associated. Jegede (1995) speaks of how science is held as sacred within African communities, and this could account for the establishment of a liturgy within school science. However, it may not be necessary to trace back to African traditional cosmology to find the roots of a pedagogical culture that religiously conserves and reveres definitions. Recitation of esoteric definitions is not a practice confined to African education systems; it has also been a feature of English education, as parodied by Dickens' portrayal of Mr Gradgrind in *Hard Times*.<sup>62</sup>

The rote learning of definitions can provide a useful survival technique for getting by in examinations that test areas of knowledge that candidates have little familiarity with. Definitions that have been tried and tested and known to satisfy examiners may be too precious to risk adulteration through rewording. Even when questions do not explicitly ask for a definition, giving the definitions of the key words within the question could sometimes provide enough marks to pass. For teachers faced with a heavily loaded curriculum that was delivered during a short period of contact time,

---

<sup>62</sup> In chapter 2, the teacher, Mr Gradgrind, tells the class that Sissy Jupe, the daughter of a horse breaker, knows no facts about horses on the grounds that she is unable to give a definition. The class swot is then asked to give a definition and duly produces a highly technical zoological definition. Mr Gradgrind then tells the girl that she now knows what a horse is (Dickens 1854/1955).



giving definitions of key terms may be seen as the most efficient way of attaining coverage.

The use of English medium could also have contributed to the prominence of definitions, especially of apparently everyday terms. Terms like 'growth', 'food' and 'fuel' are generally such familiar terms within the English language that they could be discussed in a classroom context without having to give a definition. Within the Tanzanian context this is not necessarily the case. The teachers knew that they were not supposed to use Kiswahili in class; so they did not have the option of giving a direct translation to an equivalent word that students would be familiar with, and a definition could be seen as an alternative. The conservation of the same exact wording can also be partly attributed to the language barrier. When teachers and students are not confident with the language of the phrases given, rephrasing them carries a high risk of altering the meaning. As can be seen by the examples given above, the language used for definitions was often very erudite and complex. The complex language used defended the definitions from rephrasing as it made them more difficult to understand. If teachers are unable to rephrase the definitions, they will be forced to repeat them verbatim or to only accept answers from students that correspond to the known wording exactly. In doing so, teachers increase the authority of that exact set of wording.<sup>63</sup> Students learn that only one set of wording is 'correct'; so the correct form gains value as a piece of knowledge in itself rather than being valued for the explanation that it imparts. The role of definitions within the observed lessons can be compared to Bloch's "wisdom of elders" (Bloch 1998). These utterances were not valued for their meaning, but were revered as wisdom due to the authority of their sources. The incomprehensibility of such utterances made them inaccessible to the layman, but also added to the authority of their sources and hence to the phrases themselves.<sup>64</sup>

---

<sup>63</sup> Compare with Prophet and Rowell's (1993) discussion of teachers' use of elite language in science classrooms as a way of securing their power.

<sup>64</sup> Compare with Chambers' critique of the culture of the Western academy. He points out that academic status often varies inversely with intelligibility (Chambers 1997: 35).

### 5.1.2. Categorisation of knowledge into discrete formal categories

Giving formal definitions of concepts facilitates the categorisation of much of scientific knowledge. Science, by its very nature, tends to classify and sort phenomena and objects into categories. The science curriculum in Tanzania is extensively categorised into subjects, topics and subtopics. Within the subtopics, teachers and textbooks often categorised the knowledge further, as shown in the example below:

Teacher: If someone asks you the nervous system is divided how? What will you tell them?  
Boy: Two.  
Teacher: What are they?  
Boy: Central Nervous System and the Peripheral Nervous System.  
Teacher: Central Nervous System is divided into which parts?  
Boy: Brain and spinal chord.  
Teacher: Peripheral nervous system is divided into what?  
Boy: Sympathetic and parasympathetic system.  
(Mr Andrew, biology lesson, 3/3/5)

The classification schemes given were generally presented as *the* way of organising the information rather than being presented as one of a number of alternatives. The extract above is an example of this, although arguably the classification system given here is probably the most useful way of understanding the nervous system. In another lesson (Mr Msusa, Fadhili school 26/7/5) the teacher presented a way of categorising chemical reactions. He asked for students to give types of reaction. But he only had room for five types of reaction within his categorisation scheme. He considered the scheme exhaustive and the categories discrete. When students suggested reaction types that did not fit into this scheme he rejected them. For example, when a boy suggested 'neutralisation reaction' the teacher told him: "This is not classified as an independent type of reaction."

Categorisation is a standard heuristic for making sense of knowledge, but what was notable within the pedagogical culture observed was the lack of 'fuzzy' categorisation and overlaps, with a strong insistence on discrete, formal categories. Teachers did not readily tolerate overlap between concepts, as illustrated by the following quote:

Girl: Rape is an act of violence where the victim is forced to have sex.  
Teacher: Sex or sexual intercourse? They are different.  
(Mrs Mbululo, biology lesson 02/02/05)

In the two lessons that I observed on the main food groups (carbohydrate, protein etc.), foodstuffs were assigned to discrete categories rather than being treated as composites of the different groups. For example, meat was classed as protein and potatoes were classed as carbohydrate. This led to confusion when the students attempted to position various fruits and vegetables. In one lesson “fruits” had been assigned to the class of vitamins, which led to confusion over the position of the banana, which is eaten both as a fruit and a carbohydrate base for a main meal.

In an attempt to assign phenomena discrete categorisations teachers sometimes would not acknowledge subsets within categories. For example:

Boy: is there any difference between a conductor and an electrolyte?  
[Teacher asks for definitions again and the students give them]  
Teacher: electrolyte should be in solution. A conductor can be in any state but are not in solution while electrolyte should be in solution.  
(Mr Said, trainee teacher, chemistry lesson, 8/3/5)

Here the teacher has adjusted his concept of ‘a conductor’ to distinguish it from ‘an electrolyte’ when the latter is a subset of the former.

The teacher-training curriculum also contained many instances where ideas and objects were assigned to distinct categories. In some cases this produced local dichotomies that are not present outside the Tanzanian context. For example the curriculum and teaching methods module (TIE 1999) juxtaposes the term *teaching method*, which it describes as ‘teacher expounds, lectures, holds forth, bores’, with *teaching strategy*, described as “contemporary method of teaching by planning and organising the teaching-learning experiences and situations” (1999: 17). When the distinction between terms was not made explicit, trainees would ask for further clarification as shown by the following quotes from trainees collected during observations of classes at Zebaki.

How can I differentiate between the question and answer strategy and the heuristic strategy?  
(Female trainee, 7/2/5)

Would you please, in a nutshell, give the difference between teachers' guide and teachers' handbook?  
(Male trainee, 20/10/04)

I'm confused- I failed to differentiate between teaching aids and teaching-learning materials.  
(Female trainee, 21/3/05)

This anxiety to distinguish can largely be attributed to the assessment system. The female trainee who asked about teaching aids in the above example was asking because she had been marked down in her teaching practice assessment because the assessors argued that the poster that she had prepared was a teaching-learning material and not a teaching aid. Questions starting "differentiate between..." or "distinguish between..." are commonplace at both O' level and Diploma level. One tutor made a point of alerting his students to the need to learn to differentiate between terms for the examination:

Let us elaborate so that you know, because sometimes you can be asked:  
"Differentiate between teaching tools and teaching materials"  
(Mr Nyenza, 19/10/04)

The tutors saw these distinctions as very important. When I presented my findings about the importance of categorisations to the tutors during the feedback session, all agreed that this was important and one commented indignantly that some of the trainees did not even know the difference between a teacher's book and a teacher's guide. He stressed that this was an important distinction that they needed to know.

## **5.2. Presentation of knowledge**

### **5.2.1. The lesson plan**

All teachers were officially expected to prepare lesson plans for every lesson that they taught. These were collected at the end of the week and submitted to the Head

of School. The lesson plans followed a standard format as shown in box 5.1. In practice I only saw lesson plans prepared by trainee teachers and never by practising teachers. From my own experience of working in Tanzanian schools, some Heads of School did insist on seeing teachers' lesson plans, but it was accepted practice to write these at the end of the week, after the lessons had been taught. Even though very few teachers would write lesson plans before teaching, there was some conformity in the structure of lessons. Around half of the lessons (19/45) were introduced by recapping on previous work that linked to the subject of the lesson. This often involved the students giving laws or definitions that they had learned in previous lessons. Beyond the introduction, few lessons followed the recommended format of the lesson plan as most introductions were followed by discussions that continued until the bell. Only occasionally was there a discernible separate section in the latter half of the lesson for practice (application) but never for summary.

**Box 5.1 : Lesson plan format**

Date:    Class:    Subject:    Period:    Time:    No. of students:

Topic:

Subtopic:

General Objectives:

Specific Objectives:

Teaching Aids:

Reference Books:

Lesson Development:

STAGE	TEACHER'S ACTIVITIES	STUDENTS' ACTIVITIES	TIME
1)Introduction			
2)Presentation			
3) Application (or summary)			

Evaluation:

Remarks:



### 5.2.2. Teacher led 'discussions'

Although most of the lessons observed were dominated by teacher talk, all teachers interspersed their lecturing with questions to the students. Sometimes these questions were in the form of hanging sentences, with the teacher saying "what?" or raising the pitch of his/her voice to indicate a blank for the class to fill in, as in the two extracts below:<sup>65</sup>

Teacher: Energy cannot be...?	Class: created
Teacher: or...?	Class: destroyed
Teacher: but can only be...?	Class: converted from one form to another.

(Mr Chuma, physics lesson, Fadhili school 28/7/05)

Teacher: 1 litre is equal to what?	Class: [silence]
Teacher: a thousand what?	Class: [silence]
Teacher: Centimetres what?	Class: cubed

(Mr Grayson, trainee teacher, 28/2/05)

This strategy enabled the teachers to maintain the pace of the lesson whilst attempting to involve the students in the discourse. In Mr Chuma's lesson the class had been becoming very unresponsive, but this class chorusing brought the class back together and many more students volunteered answers in subsequent discussions. Trainees were discouraged from using chorusing, but as Mr Chuma demonstrates, it can be a useful technique for bringing the attention of the class back to the task at hand.

The second extract above illustrates the limitations of this strategy, especially when it fails to engage the class. In order to maintain the pace of the lesson the trainee progressively simplified the question. As a result the gap could be filled in with minimal cognitive engagement with the problem. Prophet and Rowell (1993)

---

<sup>65</sup> Many teachers used similar hanging sentences when talking to me in English during interviews and casual conversations. Several teachers would end sentences with "what?" before completing them. This may have been in order to give themselves thinking time to answer questions in a foreign language but it could also be a habit that has resulted from the main use of English being confined to classroom teacher talk.

observed similar behaviour in classrooms in Botswana. They saw it as a coping strategy that teachers used to enable students with a poor command of English to contribute to classroom discourse by providing the syntax for them. They point out that the low level of cognitive demand required for students to complete the sentences can encourage rote learning without understanding.

As discussed above, many of the questions addressed to the class (either to volunteers or to nominated students) were answered by the students giving definitions. Most questions that did not refer to definitions received single word answers. Most of the questions given orally were fairly simple recall questions but a considerable amount of lesson time was used in going through worked examples on the blackboard. In these cases it was common practice to call a student up to the front to solve the problem on the board. Some of the more confident students would mimic the teacher, asking fellow students for the answers at each step of the solution and using hanging sentences. Teachers justified the use of this method by saying that it helped students to participate in the lesson. In a lesson spent going over an examination paper (28/07/05), Mr Chuma asked for a volunteer to solve a problem on the board by saying "who can come and teach us?" This indicated to the students that they had a role to play within the teaching process. Later on in the same lesson, when a girl asked a question, the teacher said to the whole class: "Who can answer? Not only the teacher can answer but also the students."

Here we see the teacher handing over responsibility for some elements of teaching to the class. These practices were very common and demonstrate that many teachers had given up some of their authority. The theory of the teacher being a facilitator of learning rather than the main source of knowledge was promoted by the new diploma curriculum and had been adopted by many teachers like Mr Chuma. One disadvantage of this strategy was that it was very time consuming. Mr Chuma only managed to cover a third of the examination paper during an 80 minute period.

When the teacher found an answer unsatisfactory they very rarely told the student that they were wrong. This was a deliberate strategy that teachers were explicitly taught at college.

We are advised not to discourage them from wrong answers, so don't tell them that 'you are wrong', if you tell him that you are wrong he will be serious and not raise up his hand again.  
(Mr Kivelege, interview 2/3/05)

Sometimes teachers gave mild praise such as "you have tried" but they would then give the question to another student. Other teachers would put suspect answers to the rest of the class, asking them if they agreed. As this was common practice, it was generally interpreted by the students as indicating that the answer was wrong, so they would almost invariably chorus "no". Using this technique, the teacher could reject answers that she/he was unsure about without having to commit her/himself to saying that the answer was wrong. In a discussion on sexual reproduction (Mr Mdemu 27/07/05, described below), the teacher put a student's suggestion (that plants do sexual reproduction) to the class and, as usual, the class responded "No!". When it later emerged that the original suggestion had been correct, the teacher was able to defend himself by pointing out to the class that he had not explicitly rejected the original suggestion. Another common practice was to write students' answers on the board, but if the answer was suspect it was written on the right hand side so that it did not get included with the main summary that the teacher had written in the central section. After a lesson at Zebaki during which the tutor had written all the answers to a brainstorm on the right hand side of the board, a trainee complained to me: "But we didn't reach the correct answer- the teacher wrote them on the right hand side of the board" (trainee, 16/8/5). In general, teachers and students shared an understanding as to which signifiers showed that an answer was not acceptable even though the word "wrong" was rarely heard during the lesson observation.

One of the most common signifiers of an unacceptable answer was for the teacher to simply ignore it and pass the question to another student. Prophet and Rowell (1993) observed similar behaviour in science classrooms in Botswana. They describe it as a control mechanism and argue that teachers lacked sufficient knowledge to elaborate on answers that did not conform to the accepted text. As discussed above, teachers' intention in ignoring student responses may have been to avoid demotivating students rather than to maintain their authority. Teachers also had to consider the

pace of the lesson and the coverage of curricular materials. If they spent time developing and drawing out useful concepts from individual student responses that deviated from conventional science they might have done so at the expense of developing the whole class' understanding. By ignoring responses they could move quickly onto more valid responses without having to explicitly tell students that they were wrong. Unfortunately, whatever the motivation behind this teacher behaviour, the outcome tended to be the same as explicitly telling students they were wrong, with the class interpreting the teacher's actions as signifying that the answer was wrong and the answer-giver being obliquely chastised. As Prophet and Rowell point out, this shared code helped to reinforce the attitude that answers were either right or wrong, whilst acting in a shared performance of a discourse in which all contributions were valued.

When teachers used whole class teaching they very rarely made use of textbooks and some teachers preferred students' desks to be free of books and notes. Teachers explained that this was because they felt that books could distract the students from listening to what the teacher was saying. As one teacher explained:

To my side normally I do advise them that, when at I am in the class they are not allowed to open those books,...I learnt one thing, they were using that tendency, they come with that book in the class and when you are teaching some are concentrating on the exercise books, they are not listening.  
(Mr Msuya, interview 25/1/5)

This could be seen as defensive behaviour by teachers who feared that students might challenge them in class if they could refer to their books. It is a way of securing the authority of the teacher as the main source of knowledge within the classroom. It also highlights the importance of orality within the Tanzanian classroom.<sup>66</sup> As discussed below, teachers used students' ability to give the correct answers orally to evaluate their learning. If students were able to read their answers from texts it invalidated oral questioning as a method of evaluation.

---

<sup>66</sup> This is similar to Slater's (2002) observations on orality within Theological education in Uganda (See section 1.4.5).

In approximately a quarter of lessons (11/45) students raised their own questions. Teachers invited questions more often than they received them, but sometimes students would raise questions spontaneously. Only a minority of questions that students asked in class sought knowledge that would be useful in examinations, such as asking the teacher to give a concise definition of a term used. Most questions that students asked seemed to reflect genuine curiosity, and a desire to understand wider issues in the context of the abstract concepts dealt with in class. In my presence, teachers welcomed such questions and attempted to answer them, but they were sometimes thwarted by lack of knowledge and lack of access to knowledge sources. Consider the following discussion on heart transplants:

- Boy: I heard that if you had a problem with your heart they could take it out and do experiments with it and then replace it- is it possible?
- Teacher: Is it possible? [no response] It is possible but there should be a substitute, they can use a machine. Sometimes the doctors use a machine. The heart should not be removed all of it but just a part. The machine can operate as a substitute but there needs to be gaseous exchange.
- Boy: If the heart is replaced by a machine is the person going to die?
- Teacher: Is he or she going to die? No.
- Girl: I hear that there is someone whose heart does not work. The doctors are going to put that bulb of light there. Now, I don't know, are they going to put that bulb in the heart or in the room for them to do that operation?
- Teacher: The body needs mechanical energy, the bulb gives light energy. It cannot work in our bodies.
- (Mr Abas, biology lesson, 25/7/5)

Unsurprisingly, the teacher's knowledge about heart transplants was very limited. He responded to the first two questions by asking the class first. He used any knowledge that he could to develop a convincing sounding answer to the question. In response to the girl's question about the light bulb, for example, he applied basic knowledge of physics in a logical manner. The teacher managed to maintain his position as an authoritative knowledge source, but little learning took place. Similar discussions arose in other classes and in several cases resulted in the teacher reinforcing a misconception. During a lesson on sexual reproduction, for example, a girl asked the teacher whether plants reproduced sexually. The teacher put the question to the class, who chorused "No!" and started to laugh, along with the teacher. Another girl then



challenged this verdict by pointing out that avocados need a male and a female plant in order to produce fruits. The teacher conceded that sexual reproduction may take place in a few special cases, such as the avocado, but that this was an exception rather than the norm (Mr Mdemu<sup>67</sup> 27/07/05). Teachers' lack of scientific knowledge beyond the O' level syllabus material made it difficult for them to answer curiosity-based questions and it was difficult for them to access such knowledge, as described in chapter four.

### 5.2.3. Group discussions

In 16 of the 57 lessons observed, students were asked to discuss or carry out an activity in pairs or groups. Miss Muna, a newly qualified teacher at Dafina school, taught her form four class almost entirely through assigning groups questions (lesson observation 03/03/05). This was very popular with the students who described her style of teaching as a characteristic of their best teacher. Her lesson involved each group presenting in turn on examination style questions. She had chosen the questions in order to ensure coverage of the syllabus and assigned these during the previous lesson. Students had researched the answers from books and notes before the lesson, then presented to the class. Miss Muna remained at the back of the room and kept her involvement to a minimum. These discussions were whole class discussions in the sense that questions were asked and answered by students. Several students raised insightful questions about their observations and knowledge from outside school. For example, one asked whether it was true that lemon juice could be used as a contraceptive, another asked if there were albinos in *wazungu* (white) populations.

Group discussions that were carried out during the lesson were more problematic due to lack of access to knowledge sources. Most tasks set required textbook knowledge rather than general knowledge. In some cases the questions set simply required replication of information given earlier in the lesson. In these cases students tended

---

<sup>67</sup> Mr Mdemu was a recent form VI graduate and studied the 1997 O' level biology syllabus that omits sexual reproduction in plants.

to remain silent and complete the exercise without discussion even though they had been told to discuss the questions. When the task set required information beyond what had been covered in the lesson, students used the group discussions as an opportunity to share the few text books available, or, more commonly, to share their 'hidden textbooks' of old notes of former students. As illustrated by the example of the group work on the definitions of 'growth' and 'development' (section 5.1.1), there tended to be very close uniformity in the answers as most students were using the same sources. The main outcome of group work in these cases was that the notes of a former student were replicated among many students. Although the "form" of these lessons involving group work was apparently co-operative, with the students sharing their knowledge and co-operating to research knowledge from books, the outcome was largely reproductive in nature with the disadvantage that it was more time consuming.

In other cases, especially where no notes could be found within the group, discussions did take place, but tended to be highly hypothetical, as there was very little knowledge to base it upon. One class were assigned questions from the textbook that had been written as a basis for discussion following an experiment. The book did not give the results of the experiment, only the instructions for carrying it out. The class had not observed the experiment so had to base their discussions on very limited information. Some of the questions and the answers that the groups gave are shown below:

*What is the extent of solubility of the acid in water?*

The extent of the solubility of acid in water is slightly soluble in water because only 2% of sulphuric acid can dissolve in 98% of water.

*Is the reaction between water and sulphuric acid an endothermic or exothermic?*

When you put acid in water it is endothermic because heat is absorbed because when you add water to acid it is explosive that is to say heat is given out.

*What happened to the red litmus paper and the blue litmus paper? What does this indicate?*

The thing that will happen to red litmus paper is that it will turn to blue and the thing that will happen to blue litmus is that it will turn to neutral. This shows that concentrated sulphuric acid is a bleaching agent.

(Secondary School Chemistry Book 2 (TIE 1995: 66) and lesson observation, Mr Mtewa 14/4/05)

All these answers show reasoning based on limited information. The students knew that concentrated sulphuric acid is “98%” and interpreted this to mean that it did not mix readily with water. They knew that adding water to sulphuric acid was highly exothermic so reasoned that adding acid to water would be endothermic. These arguments were reasonable enough to convince the teacher and he praised and affirmed the first two answers shown even though they were both wrong. He did not accept the third answer (also wrong), but gave a different wrong answer based on his theoretical knowledge that concentrated sulphuric acid is not classified as a strong acid. This example demonstrates another disadvantage of group work over whole class teaching in a context like Tanzania where the knowledge base of both teachers and the available texts is limited. Here the group work approach reinforced more misconceptions than might be the case with simple transmission teaching. In both this case and in the lesson on the definitions of growth, a whole class approach may have ensured more efficient and accurate learning.<sup>68</sup>

When teachers wished to show the class an object, demonstration or detailed diagram it was sometimes necessary to split the class into small groups so that all could see. Several of the trainees and less experienced teachers employed this method. While they showed each group the article in question, the rest of the class were left idle in their seats. The teachers showed no concern that most of the class was not involved in learning for most of the time. Mr Kachima, a more experienced teacher, overcame this problem by providing a circus of experiments and stimuli. For his lesson on waves he gave the whole class a general introduction to the subject using a ripple tank then gave groups a range of stimuli (a slinky, a news article about the 2004 tsunami, tuning forks and the ripple tank). It should be noted however that this teacher was an exception rather than the norm. As mentioned in the introduction,

---

<sup>68</sup> See O’Sullivan (2004) on the advantages of whole class teaching over group work.

four years previously my Tanzanian colleagues had responded to the idea of a circus of experiments with incredulity and expressed concerns that students would not all be learning the same thing.

#### **5.2.4. Other methods**

Two of the lessons that I observed started with role-plays, one about drugs and one about assertive behaviour. In both cases the teacher had asked a group of students to prepare plays on the given subject prior to the lesson. The role-plays were performed and watched enthusiastically and provided a useful basis for discussion. They were performed in Kiswahili. The role-play on assertive behaviour revealed students' own understanding of the concept as it depicted a girl agreeing to become an employer's lover in order to get a job. The teacher was able to use this to discuss with the whole class the consequences of behaving passively.

Another technique that was effective in involving the whole class was introducing an element of competition into the lesson. Mr Kigula started his lesson (26/1/05) fairly conventionally, with oral questions about the previous lesson, but unlike other teachers, he did this in the format of a quiz with boys competing against girls. As a result students were much more enthusiastic to answer than in more typical question and answer sessions. One student teacher (Mr Ramadhani, 09/03/05) conducted a brainstorm of the causes of drug abuse by splitting the class into two teams. Teams scored points for each suggestion. Not only did this make students enthusiastic to give as many suggestions as possible, it also encouraged each team to dispute the validity of the other team's suggestions. The resulting lively discussions involved students using higher order thinking skills to criticise and justify the various points given. Generating competition in the class provided an incentive to contribute to and critique classroom discourse. With the immediate motivation of the classroom competition, the focus was drawn away from knowledge for examinations.

In general, the teaching methods observed were predominantly oral. They involved class discussions, group discussions, role-plays and quizzes. As discussed below,

written work was only occasionally given in class and practical work was given even more rarely.

#### **5.2.5. Peer teaching**

Miss Muna's lesson, and the existence of the hidden textbook demonstrate that much of the transfer of information taking place in schools was taking place between students, often outside the classroom, rather than between the teacher and the student. On my return to my former school base in Tanzania at the start of my field work period, I was delighted to learn that the class I had taught chemistry to had performed exceptionally well in their form IV science examinations. I asked one of my former students if he could explain the success of his class, compared to other classes at the school. He explained to me why his class was different to the others:

“ we had,... how can I say it? '*Ushirikiano*' [co-operation]. I was the chairman, every evening we would go back to the school, we would all bring questions, some had various pamphlets at home. Sometimes I gave notes, but generally it was discussion, mainly in Kiswahili “

(conversation with former student, 30/7/04)

The evaluation of the SESS project (Frommer and Weingardt 2003) pointed to the potential of peer teaching, but noted that teachers were, on the whole, hostile to this idea as they felt that students might teach the wrong concepts. The message of participatory teaching that seemed to be coming across most strongly was that “it is not just the teacher who knows, the student also has something” (i.e. some knowledge) (Mr Athmani, 20/1/05). If this message can counter the fear that teachers have of students mis-teaching each other, then the practice of peer teaching could be supported further in schools, either during formal lessons (as in Miss Muna's lesson) or in after school clubs.



### 5.2.6. Use of Kiswahili in schools

Almost all teachers spoke mainly in English during the lessons that I observed. Around half of the teachers (13/27) used some Kiswahili, but only one teacher made extensive use of Kiswahili in an observed lesson. In contrast to this, I rarely heard lessons being taught in English when I was walking around schools. One lesson that I heard from an adjacent office was almost entirely in Kiswahili even though it was an English language lesson. As I approached one class where the teacher had already started teaching I could hear an animated discussion taking place in Kiswahili. The teacher switched to English as soon as I entered the room. During some lesson observations students would answer questions in Kiswahili, but would be reprimanded by the teacher, even when the teacher had asked the question in Kiswahili. In such cases I had a strong sense that the reprimand over language was largely for my benefit and that students were permitted to use Kiswahili when there was no observer present. My presence in classrooms clearly reduced the amount of Kiswahili used in lessons, but as a white observer it was impossible to gauge the full extent of Kiswahili use in typical unobserved lessons beyond these casual 'passer by' observations.<sup>69</sup>

The one teacher who used Kiswahili and allowed students to use it extensively in my presence, taught one of the most truly collaborative and democratic lessons that I observed. Miss Muna's lesson (see above) was a rare case of a whole class discussion where students asked each other questions and responded to each other. Many of the issues they raised went beyond the syllabus and students contributed their local, out-of-school knowledge to the discussion. When students were given the opportunity in class they usually opted for Kiswahili. The role-plays and group discussions were all carried out in Kiswahili. As shown in research by Mwinsheikke and Vuzo (2005) and Brock-Utne (2005b), when classes were carried out in Kiswahili there was much greater student interaction and co-operation in the learning process. Enforced use of English greatly restricted student involvement in lessons

---

<sup>69</sup> In a survey of secondary science teachers, 89% admitted to using Kiswahili in lessons (Mwinsheikke and Vuzo 2005).

and restricted the knowledge covered to textbook knowledge that adhered to the syllabus.

I observed several cases where students' misconceptions arising from language emerged. In several of these cases the misconception was also held by the teacher; so it was supported and propagated. Consider the following extract from a lesson on solutes and solvents:

Teacher : Who can give examples [of solutes] from everyday life?

[Students give: salt, sugar, flour, ice cream. Teacher accepts all of these and writes them down.]

Teacher : Can you give some examples [of solvents] apart from water?

Boy: Porridge

Teacher : Porridge can dissolve what?

Class: Sugar

Boy: Soup

Teacher : Soup can dissolve what?

Class: Salt

Teacher: Another one?

Girl: Sun

Teacher : Sun can dissolve what?

Class: Ice cream

Teacher : The heat which is given out by the sun is the one that dissolves the ice cream.

(Mr Maulid, Chemistry with Physics lesson, 28/7/05)

Here both the students and the teacher had confused the process of dissolving with the process of melting. In everyday Kiswahili the word *yeyuka* is used to describe both processes so here the process of the sun (or the sun's heat) melting ice cream is taken as an example of a solvent dissolving a solute. This confusion of everyday and scientific language is common even when science is taught in the learners' first language. Terms like 'work', 'heat' and 'force' have a very specific meaning in physics and the broader common usage meanings can lead to misconceptions. The difference is that in a first language situation the teacher is more likely to be able to

identify and address these misconceptions than in a situation where both the teacher and students are operating in a foreign language.<sup>70</sup>

As described in earlier chapters, Kiswahili was used for almost all aspects of school life other than the transmission of syllabus materials in the classroom. Once, during a school *baraza* (meeting) I heard an English teacher address the school at length about the importance of speaking in English. She spoke entirely in Kiswahili. Students in general wanted to be fluent in English and supported the idea of English medium education, but in practice they lacked the ability and the confidence to use English. In my interviews with students I let them choose which language to use. Almost all of the groups opted to use Kiswahili from the outset. One group that opted for English gave one-word answers to the initial questions and they could not understand the more complex questions so we changed to Kiswahili by mutual consent.

The vast majority of students (93%, n=59) that I asked said that they preferred the teacher to use a mixture of Kiswahili and English in the class. Many qualified this by saying that there were difficult terms in science that needed explaining. Teachers also sometimes justified their use of Kiswahili by saying that it was needed to translate difficult vocabulary. For example, when I asked Mrs Chambulila if she ever used Kiswahili in class she replied:

If there is a term that is difficult I give it in Kiswahili, but there must be a translation. At times I can ask 'how do you call it in Kiswahili?' then I give them the English word.

(Mrs Chambulila, interview 12/04/05)

During observed lessons the use of Kiswahili was mainly for classroom management and giving procedural instructions. Teachers used Kiswahili for allocating groups, giving out results of examinations or discussing with a class what they had done with a previous teacher. In general, teachers tended to use Kiswahili for aspects of the lesson that did not involve complex technical vocabulary. It was used when teachers

---

<sup>70</sup> See Thijs, Dekkers and Smith (1993) for a comparison of Dutch and Zimbabwean students' misconceptions of force.

wanted to ensure a response from their students that was not simply a recitation of material in their notes. Teachers would use Kiswahili for procedural instructions because it was important that students could understand and respond appropriately. Kiswahili was rarely used to explain or translate technically complex language. Only three of the teachers that I observed gave or asked for direct translations of technical terms into Kiswahili. With areas of science that involved complex vocabulary, transmission of information, often in verbatim form, was more important than understanding; so it was done in English. Students and teachers justified the relaxation of the official language policy by arguing that Kiswahili is needed to translate technical terms; however teachers tended to use it mainly in cases where simple, non-technical language was involved.

In a rare instance of Kiswahili being used to translate technical terms, Mr Kiswaga introduced the topic that he was teaching (heat) by asking the class to translate the key terms (convection, conduction, radiation) into Kiswahili (*mpitishio*, *msafara*, *mnururisho*). He wrote these terms on the board with the translations. Having done this he proceeded to discuss conduction in more detail, confident that the students knew what he was talking about as they knew the Kiswahili terms and would have studied the topic at primary level. He only gave definitions in English after the discussion. Interestingly, Mr Kiswaga had never undergone any teacher training and yet the method that he used here seems a valuable one that could be used by teachers to help students connect the science that they learn at secondary school with the science they learn at primary school. Many trained teachers and tutors told me that the content of the first two years of secondary school was a repetition of material covered at primary level, with the only difference being the language. They said that students had difficulty using their primary school knowledge in secondary schools because they were not able to translate it, and in many cases did not even realise that they were discussing something that they had already studied. It was only Mr Kiswaga, an untrained teacher, who demonstrated an effective way in which students could be assisted in bridging the gap between the two learning domains by providing a translation of the technical terms.



Some teachers code-switched to Kiswahili when talking about everyday applications of science, especially when trying to get a response from students. Teachers would either ask questions in Kiswahili or repeat them in Kiswahili after using English.<sup>71</sup> This helped to strengthen the separation of the academic textbook knowledge that was discussed in English from the everyday applications of science, which were discussed in Kiswahili. Many informants held that science could not be taught in Kiswahili as it lacks the necessary technical terms.<sup>72</sup> Some held that English was *the* language of science. Mr Mgeni, for example, responded to a question on the use of Kiswahili in school by saying;

These are English subjects, everything is written in English. If you use Kiswahili you are confusing the students, when they get to the exam they can fail. English is the international language- that's why I prefer to use it. Outside the classroom I use Kiswahili. (Mr Mgeni, 02/02/05)

Mr Mgeni's motivation for teaching in English was not to help strengthen students' language skills, or he would have taken the opportunity to do so outside the classroom where the language was less technical. Instead he supported the use of English for teaching science because he saw the language as an intrinsic part of the knowledge. 'Proper' science was seen as science in English whereas science explained using Kiswahili was considered to be less academically valid.

### 5.2.7. Taking notes

The blackboards in most of the classrooms were very large, extending the whole way across the front wall. On entering the classroom the teacher would divide the board into three columns and write the subject and the topic in block capitals in the central column. In most of the lessons that I observed, the teacher wrote extensive material on the blackboard, often filling it several times with writing and worked examples, but in many cases students did not write down what was on the board. When they did write during the lesson they often did so in the backs of soft covered exercise books

<sup>71</sup> As noted in chapter 5, teachers rarely attempted to access students' experiential knowledge and to link it with the science curriculum, but when they did so it was often done in Kiswahili.

<sup>72</sup> Kadege (2003) argues that teachers and students lack the technical Kiswahili vocabulary and hence using Kiswahili for science has no advantage over using English as both would involve learning new technical language.



rather than writing in their hard covered books that contained their notes. When a teacher wrote on the board during a classroom discussion it was generally referred to as a 'summary' and considered insufficient and lacking in detail to constitute 'notes'. The teachers had a range of strategies for giving notes, but in general it was seen as a separate activity to teaching and was often conducted in separate periods. After one lesson that I had observed, the teacher handed the class monitor his notes for her to write on the board. Other teachers told me that they would give the notes for the lesson that I had observed at a later stage. Another teacher devoted a whole lesson to writing notes while the class copied in silence. This was material that he had 'taught' during the previous lesson with that class. Mr Kasanga had a policy of giving his class notes before teaching them. He explained his strategy and rationale for giving notes as follows:

I prefer much to provide notes to them then I come with teaching. Hating that when I taught, at the same time as taking notes, they prefer much on taking notes rather than to listen, this is the problem. They will be concentrating on taking notes and not to listen, whereas if they have the notes then they will just be taking a summary and concentrating much on listening. That's why I use this technique.

(Mr Kasanga, interview 10/3/5)

Teachers sometimes gave notes in the form of questions with answers. For example, Mrs Chambulila's notes on co-ordination were laid out as follows:

### **SENSE ORGANS**

#### **1) What is sense organ?**

A mass of specialised sensory cells compacted together

#### **2) What is the function of sensory receptor cells?**

To receive stimuli from the environment.

#### **3) List down the five main sense organs in mammals**

SKIN

TONGUE

EAR

NOSE

EYE

(Mrs Chambulila, biology lesson, 02/04/05)

These notes were presented to the class written up on a flipchart sheet. Later in the lesson the teacher wrote an exercise on the board for the students to complete in

class. The set of questions was virtually identical to the ones on the flip chart so students could answer them by directly copying the summary that they had just been given. Providing notes in the form of questions facilitates the rote learning of material for examinations. Provided the teacher correctly guesses the syntax of the examination questions, students can learn the correct response without any comprehension of the question or answer.

Three of the teachers deliberately avoided giving their older students comprehensive notes with the aim that students would write their own notes. These teachers were from Alizeti and Batobato schools, where students had access to libraries and textbooks. Mr Kigula explained his policy as follows:

I just give the summary notes. They should provide notes for themselves. We are insisting them that they should go and find the notes. Actually this helps them to be creative, and helps them to understand the topic well. You know that once you get them to find their own notes they are going to use many resources, more reference books. They are going to get more knowledge about that, more than when you give the notes, when you limit them.  
(Mr Kigula, interview 26/1/05)

Speaking to the students of these teachers, I learned that this strategy had met with a mixed reaction. But many form IV students were very positive about it and claimed that having to look for their own notes improved their learning and understanding of the material. Interestingly the term used in relation to independent note writing was always “*kutafuta notes*” (to search for notes). In the extract above the teacher uses the term “to find notes”. The emphasis was on the act of looking for the sources of notes rather than on the act of composing original notes from a lengthier piece of text. As discussed in the previous chapter, many students used notes from other students who had been given their notes by the teacher. For students at schools like Batobato and Alizeti it was relatively easy to get hold of other students’ notes and this is likely to be how most students got notes in practice rather than composing their own from published sources.

#### **5.2.8. Practical work**

Of the 57 lessons observed, 16 involved some demonstration or use of a teaching aid other than a book or a poster. Four lessons involved very simple practical work in groups (using a pipette and burette, measuring height and weight, observing a spirit burner, putting metals in water). My presence is most likely to have provided an incentive to teachers to carry out practical work; so the normal level of occurrence is probably much lower. Three of the schools had laboratories and a fourth had access to laboratories at the teacher training college, but, beyond the lessons that I observed, I only saw laboratories being used on two occasions, despite spending well over two months in total at these institutions. On both occasions form IV classes were being taught qualitative analysis as preparation for the chemistry practical examination.

In the form IV national examination (O' level) all the science subjects had two papers. The first one was a theory paper, the second was a practical paper. For schools that lacked laboratories there was an "alternative to practical" paper. Of the schools in this sample, all of the town schools and Dafina school put students through the practical paper whereas at Edeni and Fadhili, students sat the alternative to practical. The practical examinations tested a specific set of experiments. For example, the chemistry practical paper always included a question on volumetric analysis and one on qualitative analysis. As students only had to answer two out of a choice of three questions they knew that by concentrating on these two types of experiment they could be confident of being familiar with the experiments that they would be asked to perform in the examination.

Although I could not find any quantitative comparison of students' performance in the two examination papers (see below) an examination officer told me assuredly that performance in the practical examination was better than in the alternative to practical examination (Kitosi 24/6/05). Teachers also believed that this was the case and saw this as evidence that practical science helped students to understand the concepts better:

Practicals make them to understand more than theory. If you compare the results of those who did the alternative to practical with those who took the actual practical, the ones doing the actual practical are doing much better.

(Mr Mgeni, interview 4/2/05)

Mr Mgeni, like other informants, attributed the higher performance to the better understanding gained through practical work. He did not question whether the two papers were of the same level of difficulty or consider that schools having the resources that enabled them to sit the practical paper were likely to be better resourced in general, which could be an alternative explanation for the improved performance. The assumed (though statistically unconfirmed) better performance in the practical examination over the alternative to practical gave schools the incentive to opt for it and then they were obliged to train their students to carry out the experiments that consistently appeared on the papers.

Despite claiming that practical work helped understanding, teachers rarely integrated it with their normal teaching. According to most informants (teachers and students) and other research in this area (see Kibga 2003), practical work was generally left until the end of form IV once all the theory had been covered. The reason several teachers gave for leaving the practical part of the syllabus to the end of form IV was that students could easily forget the practical work if it was taught during the earlier years. In the words of one teacher:

...it is just an issue of memory. If you...teach it very early, it means students could forget and then you come to repeat again, therefore wastage of time.

(Mr Chuma, interview 28/7/05)

From this explanation it would seem that the sole reason for teaching practical is to train students for the examination. Mr Chuma gave no mention of the potential role for practical work in supporting or developing theoretical aspects of the subject. The public examinations at the end of form II did not include practical papers so teachers felt no need of teaching practical work at this level.

Form I and form II we are mostly teaching theoretically and try to demonstrate much because the exam is mainly theory.

(Mr Mfikwa, interview 12/4/05)

Teachers, trainees and students saw practical work as good teaching practice and many teachers implied that they would do more practical work if resources allowed.

When talking about how they would plan their lessons if they had access to all the resources necessary, many of the teachers spoke of how they would have ideally taken the class to the laboratory to carry out some practical work. Some of the practical work they suggested used materials that were abundantly available within the school, for example, one teacher said he would have liked his class to observe preserved samples of maize and beans, but was prevented from doing so as there was no laboratory with these specimens. The school kitchen cooked maize and beans every day. The biology teachers, when describing how they would like to teach various aspects of anatomy, all mentioned improved posters or models, but none mentioned dissection of the organs they were teaching about. It was apparent that teachers felt that biology should be learned from resources made specifically for science teaching rather than from the real specimens available locally. Teachers tended to be very vague about the practical work that they would give their students; generally they could suggest little more than observing the items or chemicals.

The experiments that were assessed in the practical examination tended to be highly resource intensive. For example, for volumetric analysis every student must have access to an array of very expensive accurate measuring equipment (burette, pipette, graduated flask, balance accurate to 0.01g). The diploma curriculum promotes the improvisation of science equipment. Local production of science equipment has also been promoted through projects like the *Mzumbe Book Project* (McGuire, Nkunya and Mihigo 1994) and Teacher Resource Centres (Knamiller 1999). However, the equipment necessary for the practical examination could not be produced through local improvisation. Given that the practical examination was completely out of reach of unequipped schools, there was little incentive for them to improvise their own equipment. I did observe improvised equipment in some schools, but I never saw it used in teaching. The design of the curricular materials assumed that schools had well equipped laboratories. Practical work was inextricably associated with the experiments that were tested in the practical examination and since teachers in many schools did not have the resources to do these they felt unable to carry out any form of class practical.



As discussed in chapter four, teachers did not see practical work as a potential source of students' knowledge. Knowledge about doing experiments and the discoveries and observations made from them were seen as separate from the theoretical knowledge covered in class. Most teachers expressed a desire to provide more practical work for the students, especially in terms of providing opportunities for them to see the articles discussed in science, and yet they frequently failed to provide the articles even when they were readily available in the local environment.

### **5.3. Assessment**

#### **5.3.1. Written work**

Beyond copying notes, students were only set written work in 13 out of 45 lessons observed with teachers and 6 out of 12 lessons observed with trainees. As illustrated by the example of Mrs Chambulila's lesson on sense organs, the questions that students were assigned as written work often involved direct reproduction of material presented in the lesson. Homework was only set in 7 of the 45 lessons and tended to be minimal, with students required to write a definition or complete one calculation. When I asked about written exercises, teachers told me that there was little point in setting these as homework as the students simply copied each others' work, so there was no way of telling from the homework whether the class had understood the lesson or not. To overcome this problem some teachers set exercises during the class and collected the books from students during the lesson.

In discussions with teachers about written work, it appeared that written exercises were seen almost entirely as a form of assessment. When I put this to teachers during the feedback sessions, the majority agreed. When pushed, a few teachers added that written homework had the function of 'keeping students busy' in the evenings. Two teachers told me that doing written exercises could help students to remember the work better, but only one teacher, an unqualified form VI leaver, gave the impression that he saw setting written exercises as a way of building and strengthening students' knowledge. He did this by comparing learning science through exercises to learning to ride a motorbike through practice.

I believe that when a person is making an exercise it will be improving his competence, improving his knowledge. It is very difficult to learn just from speaking.

You know, I was riding a motorbike. The first day it was very difficult, but then I was gaining confidence. If there are no exercises then they will just remain at rest, those exercises are like an external force.

(Mr Gerald, interview 10/3/5).

When asked about the characteristics of a good teacher, many students mentioned the setting and marking of lots of exercises, but the large class sizes meant that this could be very labour intensive for the teacher. The lack of textbooks was also a limiting factor in setting problems for homework, as in many cases homework questions had to be copied from the board. This limited the number of questions that it was practical to give.

### **5.3.2. Oral assessment**

Teachers who did not give students any written work claimed to evaluate students' understanding from their response to oral questions. This form of assessment took place during the lesson in which the material was covered, but also during the introduction of the following lesson. Teachers claimed that an advantage of participatory methodology was that it enabled them to evaluate students' learning as they went along. As Mr Chuma explained:

Then when students participate then it's where evaluation is very simple, especially oral questions. (Mr Chuma, interview 28/7/05)

Generally teachers claimed to be satisfied with students' understanding and would tell me that they were confident that most students had understood. Even in lessons where the vast majority of the class had remained silent, teachers seemed satisfied that the answers from the vocal minority indicated understanding in the majority. It was important to teachers that the oral responses came from memory rather than being read from notes and they would reprimand students if they spotted notes open on their desks during discussions.

### **5.3.3. A binary model of understanding**

The official lesson plan format included a section on evaluation (see box 5.1). From the lesson plans of trainees that I observed it appeared that there was a stock phrase that was used to fill this section, which in most cases that I saw read:

97% of students understood. This was proved by doing well in assignments and oral questions.  
(trainee teacher's lesson plan, 28/2/05)

During a debriefing session, the tutor from Zebaki reaffirmed this as the correct way to evaluate a lesson and stressed the importance of the quantification.

Trainees and teachers were often satisfied that students had understood based on relatively little evidence. This could partly be attributed to teachers' own familiarity with not understanding, as discussed in chapter four. Oral recall of content that the teacher had discussed was taken as evidence of understanding. In a lesson on molar volumes of gases the class did two calculations in the lesson and most of them struggled with these. In the interview following the lesson the teacher claimed that he was satisfied that the students had understood and he planned to continue with a new topic the following lesson without setting further exercises on the topic (Mr Yusuph 2/2/5). As discussed above, with the exception of Mr Gerald, few teachers saw the need for students to be given the opportunity to manipulate and reformulate the new knowledge acquired during the lesson. A common 'folk psychology' that emerged from observation and conversation with teachers was one that involved a binary model of learning. Learning was seen as a one step process and students had either 'caught the concept' or not.<sup>73</sup> This model enabled teachers to quantify the number of students that they claimed to have understood the lesson. This differs from the folk pedagogy model of learning found by research carried out in Israel (Strauss and Shilony 1994). Learning was seen by many teachers as a two-stage process, one of 'input' followed by a concretisation process which was facilitated through exercises.<sup>74</sup> Within this model the exercises are an important part of the learning process itself and not just a tool for assessment.

---

<sup>73</sup> During research with Tanzanian Primary teachers the teachers and researcher developed a metaphor for teaching of throwing a slippery ball for students to try to catch. See Barrett (2005).

<sup>74</sup> I found similar findings to Strauss and Shillony in a mini research project that I carried out with trainee teachers in Scotland (Wedgwood 2003b).

It could be argued that this binary model of learning corresponds to shallow learning (Entwistle 1984). It leads to an atomistic and quantitative view of learning in which mastery is equated with knowledge of a large quantity of facts rather than ability to access, interconnect and utilise knowledge.

#### **5.3.4. Tests and examinations**

All schools set regular internal tests and examinations. Some schools (e.g. Chambuzi) had a double period set aside each week for the students to sit written tests. Each week they would be examined on two different subjects and so each subject was tested roughly once per month. All schools set mid-term and end of term tests. These were generally printed tests written in the style of the national examinations, often using questions from past papers. The students tended to spend a week off timetable to sit these tests. The marks from internal tests were compiled and aggregated to give the continuous assessment mark for students which was submitted to the National Examinations Council.

All school and teacher training final assessment and certification were administered by the National Examinations Council of Tanzania (NECTA). I attempted to access information and evaluations of NECTA examinations but this was highly problematic. The protective and defensive culture encountered at NECTA is very understandable given its recent history, which has been fraught with examinations leakage (Kitosi 2002; Guardian 2004). An unfortunate consequence of this is that it is difficult for independent researchers to access information that could be valuable for the evaluation and analysis of student performance. As executive secretary of NECTA, Dr Ndabi told a conference in 2003:

Unfortunately no comprehensive and systematic analyses and documentation on the validity and reliability has (sic) been undertaken on NECTA examinations.  
(Ndabi 2003:57-58)



When I enquired in 2005 I was given the same answer. I was also refused access to any form of breakdown of marks such as mean percentages scored or the mean scores in different papers (theory, practical and alternative to practical.)

Students' achievement in secondary school subjects is officially measured by their performance in a final examination administered by NECTA (50% of mark) and continuous assessment carried out by the school consisting of two internal examinations each year (45% of overall mark) and a group project (5%). In practice the school-based continuous assessment component makes a negligible contribution to the individual student's final mark as it is factored out by the moderation procedure in which any deviation between a candidate's examination mark and their continuous assessment mark is attributed to over lenience (or strictness) of the teachers. The final score is calculated from the final examination score with a universal moderation factor derived from the national average of continuous assessment marks (Ndabi 2003).

NECTA have produced detailed tables of specifications for each subject mapping the skills that are tested in each topic (NECTA 2003). According to the tables, science examinations are designed to focus mainly on higher order thinking skills. The theory papers are designed to have only 16%, 20% and 33% of questions testing for knowledge for chemistry, physics and biology respectively. The majority of the questions are officially aimed at testing comprehension, application, analysis, synthesis and evaluation. According to my own analysis of the 2004 science theory papers the percentage of questions that could be answered using recall alone was 35%, 37% and 70% for chemistry, physics and biology respectively, roughly twice the figures given in the tables of specification. Questions on the chemistry and physics papers that involved writing chemical equations and doing calculations also required recall of the reactions or formulae involved; so while they tested higher skills they also tested recall and the marks for the higher skills were not accessible to students unable to recall the formulae correctly. Given that the vast majority of



students score a D or below<sup>75</sup> (less than 40%) we can assume that only a tiny minority of students are able to access the questions that allow them to employ higher order thinking skills. Memorisation remains the best survival strategy.

The definitions that were such an important part of lessons also featured prominently in the examinations. All papers had a “matching items” question that required candidates to match a list of terms with phrases from a second list. Around half of these items involved matching a term with its definition. All three papers had other questions explicitly asking students to give definitions of various terms although these questions only accounted for a few percent of the total mark. More common were questions that asked students to ‘explain’ terms or to ‘differentiate between’ pairs of terms. From observing teachers going over examination papers in class it was clear that the accepted way of answering these questions was by stating definitions of the terms mentioned. In total, approximately 20% of the biology 2004 paper could be answered by stating definitions.

Examiners were drawn from the population of teachers and were also products of the education system themselves. Anecdotal evidence from teachers who had been sent for marking indicated that there was little flexibility over what answers were considered acceptable, and being correct involved conforming to the answer that most teachers were expecting. For example, one teacher commented:

We were marking those form II exams and one student answered in a different way that people are not accustomed, especially teachers, and when I tried to convince them that it was correct, they said “let us stick on what we have agreed, not right in the sense of wrong and right, but in the sense of what is required.”

So if I was the person to give the last say, then I could probably give them the marks but I’m not sure about my fellow teachers so I prefer much to stick on what people agree.

(Mr Msusa, interview 26/7/5)

---

<sup>75</sup> In 2004 the percentage of candidates scoring grades A-C was 24% for biology, 41% for chemistry and 20% for physics.

The form of assessment at the time of this study, while proclaiming to depend largely on 'continuous assessment' in practice depended almost entirely on examinations. The examinations were intended to test higher order skills but in practice could be answered largely through recall. In most cases the questions were relatively closed with limited alternatives. Anecdotal evidence suggested that students whose answers did not conform closely to a common text were not awarded marks. Given the style of examinations, teachers' focus on definitions and textbook knowledge was a pragmatic approach to classroom pedagogy. Without considerable change in the form and style of assessment at secondary schools it seems unlikely that efforts to make education more participatory will go much beyond changing the form of information transfer in schools. The source of knowledge in classroom discourse is likely to remain the textbook or the tried and tested notes rather than student experience and wider literature.

#### **5.4. Authority of the text**

The idea of participatory pedagogy had been enthusiastically adopted by many of the informants of this study, especially the teacher trainers, curriculum designers, recent trainees and teachers that had received in-service training. Teachers tried to make their lessons more participatory by using extensive oral questioning. Group work, role-plays and oral competitions were also used. In many cases teachers had developed a classroom atmosphere where students were confident to raise questions of their own. Many teachers explicitly sought to hand over some authority to the students within classroom discourse. The authority position of the *teacher* appeared to be less of a barrier to the adoption of a participatory methodology than suggested in research in other African contexts (see e.g. Jansen 2005a, Jegede 1999, Tabulawa 1997). On the other hand, classroom culture preserved the authority of the *text* and this meant that participatory methodology, as enacted within classrooms, still remained largely reproductive. Students participated in a classroom discourse that passed on textbook knowledge in a conservative manner. Just as Horton (1967) argues that Africans have a sacred attitude towards words and Jegede (1995) argues that they have a sacred attitude towards science, the teachers and students in this

study appeared to have a sacred attitude towards the body of textbook knowledge passed on through the hidden textbook and through science lessons. This body of knowledge was treated as a sacred text in that it was treated as if it had intrinsic power beyond the meaning that it gave. It was treated reverentially and conserved in its verbatim form. The sacredness of the approved text remained a barrier to involving students more actively in the contribution of new knowledge to the classroom. It also limited the use of pedagogical practices that would encourage students to construct their own learning through manipulation of new information.

The teacher was not seen as the source of knowledge in the science classroom, but was there to endorse the validity of the knowledge discussed. The fragility of the teachers' own knowledge meant that they were unable to endorse knowledge that deviated from the approved text. During classroom discourse, only answers that conformed closely to the approved text were accepted as right and those that deviated from it were implicitly treated as wrong. Opportunities for students to participate in learning through written work and practical work were very limited. A possible explanation for this is that teachers tended to see learning as a binary process involving a one-stage input of verbal knowledge. The role of practical work was seen as training for the examination. The role of written work was seen as a way of evaluating whether students had learned to replicate the knowledge endorsed by the teacher. There was very limited acknowledgement of the role of experience or practice in learning. This one-step input model of learning could reflect teachers' own experience of learning at school. If they employed surface learning as a survival strategy during their own schooling then they may not have had much experience of deepening their learning through practice and manipulation. Lacking experience in deep learning, they may have been unaware of its potential benefits and so did not attempt to promote it in class.

The classroom culture observed can be seen to consist largely of survival strategies that have been developed to bridge the gulf between the aspirations and the reality of the education system. The government and much of the population aspire to gain fluency in English sufficient to study all subjects in English and yet students

struggled to compose even simple sentences and so resorted to one-word answers or recitations of definitions. The system aspires to deliver a science curriculum with extensive practical work, but practicals were only carried out as training for those who sit the practical examination. The system aspires to take on trainee teachers that are confident in their subject knowledge, but teacher subject knowledge remained a barrier to employing participatory methodologies. The following chapter explores this gulf between aspirations and reality and looks at how short-term survival strategies can become ingrained cultural practices. It considers how erosion of tacit, non-verbal knowledge can occur as a result of this gulf, and how this leads to the elevation of the status of certain texts to a level of sacredness.

## 6. The Race for Modernity: Analysis of the Influences on Pedagogical Culture

We must run while others walk  
Nyerere<sup>76</sup>

Kabla mtoto hajaanza kutembea, ni lazima atembae  
(Before a child walks, he must crawl)  
Mr Mdemu, biology class 27/7/2005

This chapter looks at the appropriateness of Western pedagogical styles within the Tanzanian context. The development of education in Tanzania, as discussed in chapter two, is notable for the late and limited development of post-primary education, periods of rapid expansion and scarcity of human and physical resources. According to a linear evolutionary stage theory of educational development such as that proposed by Beeby (1966), Tanzania is still at an early stage of educational development and it must progress through the intermediate stages before it is ready to take on pedagogical practices of the final stage of 'meaning'. But the Tanzanian teacher is working in a society that is influenced by symbols of modernity from abroad. Instead of a gradualist approach to incrementally developing the education system, Tanzania has tended to adopt policies that aim directly for a modern gold standard. Tanzanians have sought to 'run' to catch up with an image of Western education. Teachers are trapped in a gap between the aspirations of a society to be modern and a reality that is far removed from the aspiration. In order to bridge this gap, teachers and students have developed survival strategies that have become common practices. These survival strategies have contributed to the construction of a folk pedagogy that treats science as a set body of text and sees learning science as a one stage input process. This folk pedagogy acts as a barrier to the adoption of Western pedagogical approaches, which themselves are seen as modern and desirable. A consequence of the race to attain certain aspects of the image of

---

<sup>76</sup> Nyerere is reported to have frequently used this phrase to refer to the development of Tanzania. See Hyden (1979), Jennings (2003: 184), Smith (1973: 202). Several informants quoted it to me during casual conversation, saying: "As Nyerere used to say...". The manifesto of the ruling party, Chama Cha Mapinduzi (CCM) for the 2005 elections uses this phrase (cited in Mnganya and Johnson 2005).



modernity (fluency in English, mass education, laboratory based science) is that it has effectively inhibited the attainment of another aspect of the image of modernity, namely Western teaching methodology.

### **6.1. Is the current pedagogic culture just a stage in development?**

The dominant pedagogy described in the previous two chapters was one where teachers stressed verbatim definitions and where the ability to reproduce these was seen as evidence of learning. Students were given few opportunities to contribute their experiential knowledge to lessons or to construct their own understanding through observation or solving problems. These aspects of the pedagogical culture will be familiar to any observer of pedagogy- in both Southern and Northern contexts. The “hidden textbook” that contained a set of notes that could be memorised and used as a source of answers for examinations questions is not greatly dissimilar to the “revision guides” popular with students in the UK. It is not uncommon for teachers elsewhere to follow the textbook religiously or to reject students’ answers that deviate from the approved text. It is difficult to identify aspects that are peculiar to Tanzania or even to Africa as a whole. It could be argued that many of the pedagogical practices observed are simply the default practices that educators resort to when they have limited resources in terms of books, equipment, general education and teacher training and when they feel under pressure to cover the syllabus material in a limited time. Comparing the observed pedagogy in Tanzanian schools with Beeby’s model (1966) and the elaborated model described by Verspoor and Leno (1986), as described in chapter one, many aspects fit into the *formalism* stage and some aspects indicate a progression into the *transition* stage. Learning was dominated by rote memorisation of phrases and lists that were valued for themselves rather than for the meaning that they imparted. Assuming that these observations are representative of secondary science education throughout Tanzania, and applying Beeby’s model, it could be argued that Tanzania is simply going through a stage where other countries with more advanced education systems have been before. Progression to the stage of *meaning*, at which constructivist methodology might be used, can only come about once the system has passed through the earlier stages and

once the prerequisite conditions are met (well resourced schools, well educated and trained teachers).

More recently, researchers considering pedagogical intervention in African education systems have also promoted the idea of introducing change gradually and at a level that is appropriate to the stage of the teachers (see e.g. O'Sullivan 2004). Rogan and Grayson (2003) argue that innovation is most likely to be effective when it proceeds just ahead of current practice. They use the term *Zone of Feasible Innovation*, based on Vygotsky's concept of the *Zone of Proximal Development* in learners (Vygotsky 1934/1962: 103), to refer to the range of pedagogical devices that are an improvement on current practice, but similar enough to be readily accepted by teachers. According to their theory, when innovations go beyond the limits of this zone, teachers will either give up any attempt to implement the change or, when there is a strong directive culture, they will develop strategies to ensure that they are following the form of the change without following the essence. This adoption of the form of pedagogical change without the substance was observed by other researchers investigating educational change in South Africa (Brodie, Lelliott and Davis 2002). Applying this concept to the observations of this study, aspects of participatory methodology that were closest to existing modes of teaching and learning, such as the oral answering of a teacher's questions by individuals or groups, were accepted and adopted into classroom practice. The idea of allowing students to construct their own scientific knowledge through experiences, as promoted by much of the material on the TEP course, may be too far beyond the zone to be adopted.

Models of educational development that treat Western pedagogical models as a universal ideal leave countries like Tanzania trapped into a position where they are constantly trying to catch up with the West. In this situation, societal expectations can lead to political pressure to attempt to accelerate development and to 'run while others walk'. At the same time Beeby's model and the other studies mentioned above promote gradual change and support the idea that developments introduced to the system will only work if they are at the appropriate developmental level. According to this, teachers should "learn to crawl before they walk" and concentrate on

ensuring the transfer of accurate content knowledge through traditional lecture based methods before attempting to use participatory methodology. This returns to the pivotal question from colonial times of adaptation versus replication of Western systems: should education be adapted to Tanzanian realities with the danger of denying them access to more marketable skills or should Tanzanians attempt to replicate current Western models of education?

Beeby's model helps to explain some of the problems and realities of education in Tanzania, but Tanzanian education cannot be considered to be an isolated system developing along a linear pathway towards a goal that other countries are closer to attaining. Tanzania is bombarded with symbols of modernity from abroad. These symbols have been taken to build up an image of modernity that has formed the popular goal for education in Tanzania. But at the same time it has influenced the progress towards that goal, often acting as a barrier rather than an aid to achieving the goal.

#### **6.1.1. The image of modernity**

Studies of education in Africa (e.g. Fuller 1991), and in Tanzania in particular (Stambach 2000; Vavrus 2003), have associated much of what takes place in education as a quest to become modern. Governments, communities and parents make great efforts to expand their education systems in order to give the next generation the opportunity to become modern. The image of what is modern is compiled from images of the West within the local context. Many Tanzanians seek fulfilment of this quest through migration. Just as Vavrus found in the North of Tanzania (2003: 9), many of my conversations with teachers and students revolved around getting sponsorship to study abroad. Few expressed a desire for permanent migration. The goal of going abroad was generally to get a Western, 'modern' education.

As discussed in chapter two, the education policies of the British administration in colonial Tanganyika, of Nyerere and of international donor agencies since the

Education for All (EFA) movement have striven to promote basic, relevant education for the majority and to de-emphasise secondary academic education. Despite these policies the desire for academic secondary schooling has not been curbed. Dore's argument (see chapter two and Dore 1976) that the desire for academic education is driven by an over-saturated employment market in the modern sector at first appears difficult to apply to the Tanzanian case. In Tanzania, post-primary education has been so restricted that the employment market for those with secondary education and above has not been saturated (Mukyanuzi 2003; World Bank 2004).<sup>77</sup> But the restricted supply of secondary education did not dampen people's desire for it; it simply created a bottleneck at the point of entry into secondary schools rather than at the point of entry into the labour market. Arguably, it increased the desire for secondary education rather than decreasing it, as secondary education became a passport to a modern sector job. The strength of the desire for secondary education is indicated by the willingness of communities to contribute time and money to building secondary schools. Since the liberalisation of the education sector in the mid 1980s many communities have joined together to build their own secondary schools. Under SEDP, the government has agreed to assist local communities in building schools. The number of secondary schools has increased rapidly as communities have striven to give their children access to a modern education (see chapter two).

At a policy level, a key rationale for the development of the education system is the need to promote science and technology. The foreword to the *Education and Training Policy* (1995) states that:

The shortage of scientists, engineers, teachers, doctors, nurses and other high level skilled personnel in agriculture and industry deprives the country the ability of adapting and developing new technologies and skills, based on in-country research and applying the results to the local production of goods and services.

(MoEC 1995: foreword)

Science education was seen as important for training professionals and to develop Tanzania's own research capacity. The *Development Vision 2025* (URoT 1999)

---

<sup>77</sup> These studies were carried out on cohorts graduating in the 1990s. The situation is likely to be changing as a result of recent expansion of the secondary education system.

strengthened the call for science, claiming that science education was not simply needed in order to train a minority professional class, but that it was necessary for *all* Tanzanians:

The education system must instill a science and technology culture from its lowest levels, giving a high standard of education to all children between the age of 6 to 15. Basic sciences and mathematics must be accorded signal importance in keeping with the demands of the modern technological age. Science and technology education and awareness of its applications for promoting and enhancing productivity should permeate the whole society through continuous learning and publicity campaigns.  
(URoT 1999: 4.2.iii (sic))

When I asked a group of students at Alizeti school why they had opted to study science they told me that it was because this was the “*karne ya sayansi na teknolojia*” (century of science and technology)(student focus group, Alizeti school, 27/01/05). I frequently encountered this phrase elsewhere in Tanzania; in informal conversations, newspapers and political speeches. Many students claimed to have opted for science for vocational reasons, saying that they hoped to become doctors or engineers. Some claimed that it had been a strategic choice as they thought that there was less competition for places in higher education and for jobs in the sciences than in the arts. In practice the science streams at most of the schools visited tended to consist of the students who had performed well across the board in their form II examinations. It was almost taken for granted that those with the ability to study science would want to do so. Science was seen as desirable as it made the individual modern and equipped them to modernise their country through medicine, engineering or other applications. It was also seen as a necessary life skill for all citizens of this “modern technological age”.

Neke (2002) describes how science and technology have become inextricably linked to English medium education within Tanzania. Most scientific literature in Tanzania is in English and the learner needs fluency in English to access it. This has given rise to the idea that English is *the* language of science and that other languages, such as Kiswahili, are not sophisticated enough to describe scientific phenomena (Brock-Utne 2004). This is one of the rationales frequently given to support the use of



English as a medium of instruction at secondary level (see section 5.2.6). But fluency in English is in itself a key indicator of modernity within Tanzanian culture. The desire for fluency in English is often linked to the desire to be educated outside Tanzania. One of the common rationales given for using English as the medium of instruction, even in policy documents (URoT 2001), was that English enables students to study abroad. For the average Tanzanian secondary student the chances of getting the funding to study abroad are very low indeed and yet it was still a common aspiration, and one for which many were willing to pay the price of studying through a foreign medium in the hope of success. English is necessary for many of the better-paid jobs in Tanzania: jobs in tourism, multinational companies and with international development agencies. It is therefore not surprising that the desire to learn English is very strong. This strong public desire to learn English has made English medium education very popular. As Dodd had found during his research on the level of English within schools (see section 2.5), almost everyone that I spoke to on a casual basis during my fieldwork supported the continued use of English as the medium of instruction in schools. Parents who could afford to, often opted to send their students to private English medium primary schools (Rubagumya 2003). Education in English has become associated with quality education and changing to Kiswahili medium education at secondary level would be seen as a regressive step. Proponents of Kiswahili medium education argue that students could learn English more effectively if they were allowed to develop their literacy in a familiar language and there is substantial evidence to back their claims (Roy-Campbell and Qorro 1997). However, this argument is too counterintuitive to curb the popular demand for English medium education. In the popular image of modernity, learning English means learning *in* English.

Among the education professionals, images of modern pedagogy were an important aspect of the image of modernity. The introduction of participatory methodology into education discourse has helped to form an image of “modern education”. As mentioned in chapter two, at the ministry level, the emergence of participatory teaching methodology was seen as part of a recent global phenomenon. For example,

the co-ordinator for the diploma level initial teacher training at the Ministry of Education and Culture commented:

The pedagogy change was a global issue, in my own opinion it followed the changes in technology. Trying to involve students in researching their own knowledge. For example, many are now using the internet. We needed to change the traditional methods.

(Sarah Kironde, MoEC, Department of Teacher Education, 22/6/05)

The association of participatory methodology with globalisation and modernity may help to explain teachers' readiness to adopt it, at least as a term with which to describe their own practice. The recent changes to the teacher training curriculum is indicative of policy that is focused more on attaining a modern ideal form of teaching than on the realities of teacher capabilities under current recruitment practices. The diploma curriculum has been written with the assumption that trainees have robust content knowledge. The pedagogies promoted through programmes like TEP were developed in a European context where most teachers have experienced much more extensive and higher quality education in their subject areas. Just as with the discourse over the expansion of secondary education, science education and English medium education within the Tanzanian context, the position of participatory methodology within the image of modernity tended to override considerations of appropriateness within the local context. Modern science teaching was seen as something involving extensive practical work and use of teaching aids. When trainees were asked to describe the characteristics of their best science teacher the most common characteristic mentioned was that the teacher carried out many practicals and demonstrations. Extensive use of teaching aids was the third most commonly mentioned characteristic (see chapter four, section 4.3.1).

All of the above contribute to the image of modernity and they are reflected in the country's education policy. Pursuit of any one aspect of this aspiration has implications for the acquisition of the other aspects. The rapid expansion of the education system has led to resource scarcity that has inhibited the implementation of participatory learning and the learning of science. It has reduced the quality of English teaching at primary level and this has made it difficult for secondary schools to implement an English medium policy. The choice of English as the medium of

instruction has also inhibited the implementation of participatory methodology and has limited the understanding of science. Images of science drawn from abroad clash with ideas central to participatory methodology (in itself, an image drawn from abroad) that learning should involve the knowledge of the student that is derived locally. In the process of striving for a goal of modernity, Tanzania has set itself obstacles in reaching its own goal. The processes by which these aspirational goals have been self-defeating are elaborated below.

## **6.2. Pedagogical outcomes of the race for modernity**

In this section I have constructed a speculative model (see figure 6.1) to try to explain the emergence of the two key elements of pedagogical culture identified in chapter five; the 'sacred text' and the 'binary model of learning'. The sacred text refers to the body of liturgical phrases that were treated with high value and authority within science lessons. This included definitions, discrete lists and categories. The sacred text defined what was valid knowledge in the classroom. The binary model of learning refers to the conception that learning is a one-stage process. Within this conception, replication of the codified knowledge is sufficient as evidence of learning and little value is given to the manipulation of knowledge within the learning process. In the lessons observed, tacit, uncoded knowledge developed through practice did not appear to be recognised or valued.

These two facets of folk pedagogy are self-fertilising. As the value of the sacred text becomes elevated, uncoded knowledge becomes devalued and memorisation becomes the most important aspect of learning. This supports the binary model. Within the binary model of learning, the ability to recall part of the sacred text (e.g. a definition or a formula) is seen as sufficient evidence that learning has taken place. This helps to elevate the value of the sacred text. This model takes the race for modernity as its starting point, considering the influence of rapid educational expansion, the pursuit of 'proper' science and the use of English. It and looks at how this race at a national level could lead to the nurturing of these traits of pedagogical culture within the classroom.

I argue that these two elements of pedagogy are at odds with the constructivist model of teaching and learning promoted by TEP and the version of participatory methodology given in the Ministry training documents (see figure 6.2). Both reduce the extent to which students can participate in knowledge construction. The sacred text reduces the teachers' and the students' capacity to alter, manipulate or reconstruct the codified element of science education. Within a conception of scientific knowledge as a body of sacred text, experiential knowledge is not valued and few attempts are made to access it or generate it. This is directly antithetical to the idea that learning should draw on the child's knowledge from out of school. The binary model of learning demotes the position of practice and problem solving in learning. According to the model outlined in figures 6.1 and 6.2, pedagogical models that have arisen from, or been strengthened by, the pursuit of modernity (secondary schooling, 'high' science, English medium education) conflict with the idea at the heart of "modern" (i.e. Western) pedagogical theory, that the students are involved in their own knowledge construction.

According to this model, it is highly unlikely that participatory methodology will be adopted by teachers without a considerable degree of adaptation. This fits with the observations of teachers who had adopted participatory teaching methods, such as group discussions, but had adapted them to conserve and replicate the sacred text.

Figure 6.1: How the image of modernity could lead to the observed pedagogical culture

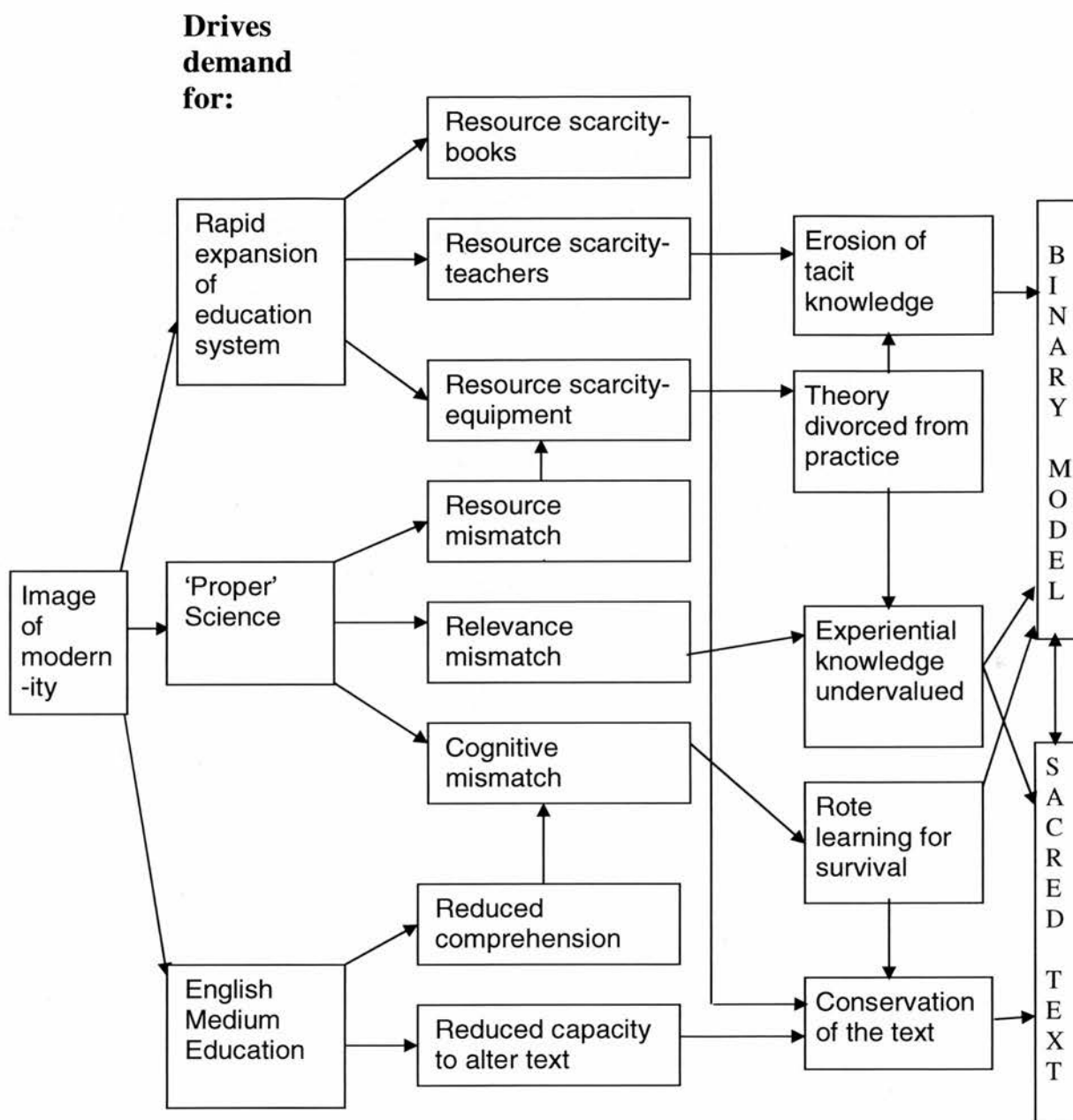
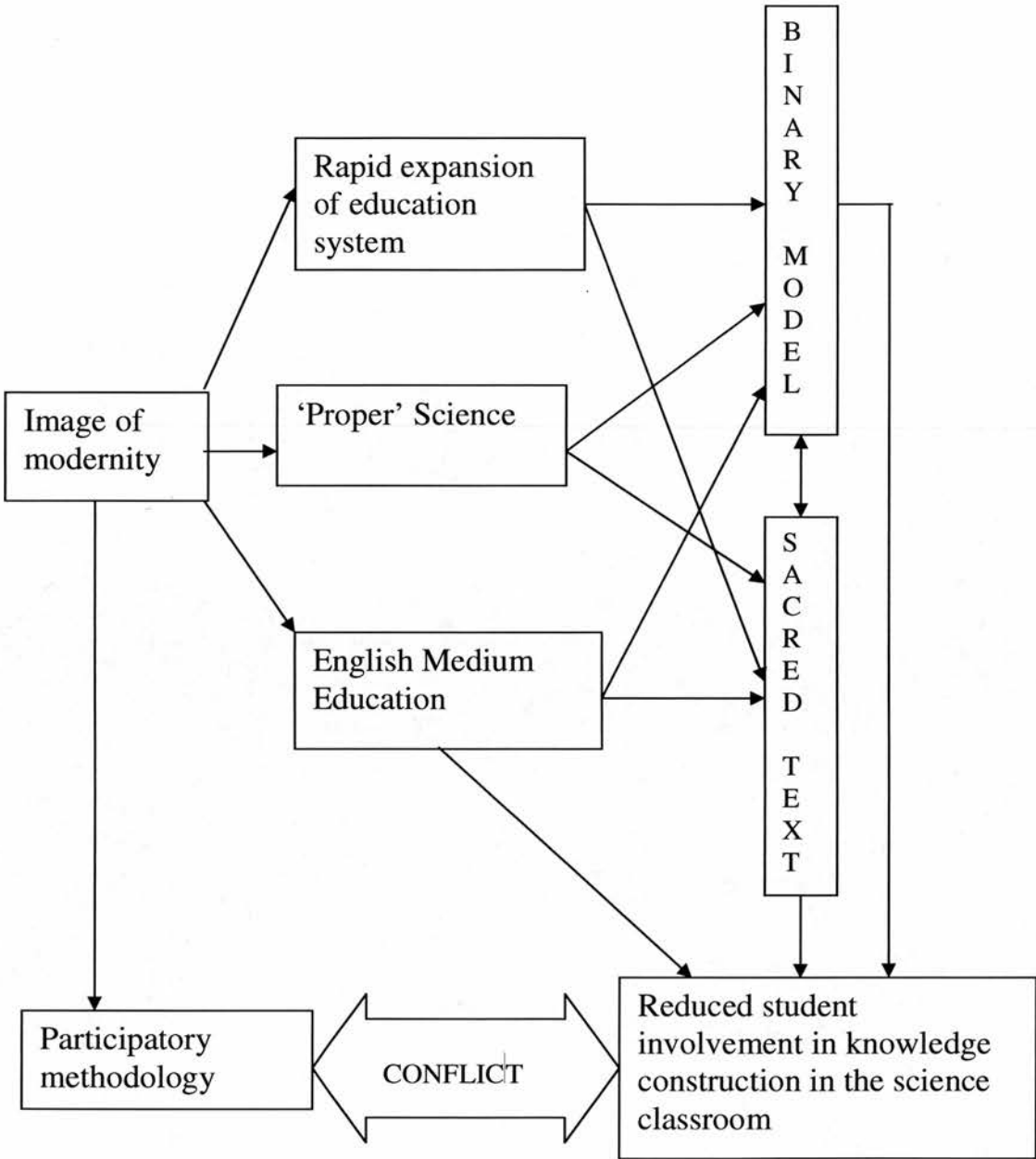




Figure 6.2: How pedagogical culture arising from the image of modernity clashes with Western models of participatory methodology.



### 6.2.1. Rapid Expansion of the Education System

As we have seen in chapter two, the education policy of the colonial power tended to take a gradualist approach, focusing on mass education at a basic level and only developing post-primary education at a late stage. As a result, at Independence the country had very limited education beyond primary schooling. Since Independence there have been periods of rapid expansion within the primary education system under UPE and PEDP. The expansion of the primary education system under the 1970s drive for UPE had implications for the quality of education at secondary level. Funding the expansion left few resources for secondary education. The fall in quality of education at primary level meant that students entered secondary education with very poor foundations for learning. The level of English was particularly low among students starting secondary school (Cooksey 1986). More recently there has been rapid expansion of the secondary system under liberalisation and SEDP. The private secondary sector expanded rapidly in the late 1980s and early 1990s due to liberalisation. Since the mid 1990s the number of government secondary schools has increased dramatically (see chapter 2 and Wedgwood 2005). Rapid expansion of the education system, combined with the economic setbacks of the 1980s left the education system as a whole in a situation of severe resource scarcity. The system, both at primary and secondary level, lacked books, equipment and well-qualified teachers.<sup>78</sup>

#### *Resource scarcity - books*

As discussed in chapter four (section 4.5) the quantity and variety of textbooks available to learners and teachers were often very limited. In some of the rural schools in this study there was only one copy of the main textbook for a class in some science subjects, so only the teacher had access to the textbook. This gave rise to the survival strategy of students generating their own 'textbooks' by borrowing or copying the notes of students who have gone before them. The textbooks provided by TIE and the copied notes followed the syllabus exactly. Students and teachers

---

<sup>78</sup> Whilst the vast majority of teachers had teaching qualifications, the qualifications were below the minimum requirements as stated in the *Education and Training Policy* (MoEC 1995) of grade A for primary teachers (O' level and college certificate) and degree level for secondary teachers teaching above form II.

familiar with relying on these texts lacked experience and confidence of using alternative texts that organise knowledge into different topics and present it in a different sequence. Students' access to textbooks was also constrained by their limited comprehension of English and students tended to prefer to use 'summaries' distilled by the teacher from the text than to refer to the textbooks directly. The reliance on copied summaries and the limited access to alternatives helped to conserve one version of the science text. The conservation had contributed to the sense of sacredness of the text. As a text becomes sacred, it gains status over the value of experiential knowledge and also over new texts. As a wider range of textbooks has become available, their utility has been judged according to their conformity to the sacred text. Those that deviated too far were not used. This was the case of many of the more recent science textbooks in the Zebaki TTC library. Shortages of books in the past may have helped to establish a culture in which the conserved sacred text gained so much authority that it served as a barrier to the use of more modern published sources even when they were readily available.

#### *Resource scarcity- teachers*

Teacher effectiveness studies tend to show only very weak links between teacher effectiveness and teacher education in developed countries, but the links appear to be much stronger in developing countries (UNESCO 2004: 65). As described in chapter two, in the first decade of Independence in Tanzania, the secondary school system had to rely heavily on expatriate teachers. Expatriate teachers of the 1960s often came from resource rich educational backgrounds (Wedgwood 2003a). Nationalisation policies led to a rapid withdrawal of this expatriate teaching force. They left faster than the fledgling tertiary education system could provide graduates to replace them. As a result, a mainly graduate teaching force was replaced by a teaching force of mainly diploma holders (see chapter two). The 1995 education and training policy (MoEC 1995) asserted that forms III and IV should be taught by graduates even though this was clearly not achievable in the near future. The majority of secondary teachers teaching forms I-IV in 2005 did not have a university education and would have been taught O' level by teachers without university education. Whilst the size of the secondary teaching profession has increased greatly,

the depth of scientific knowledge within it has been reduced since Independence. The way that teachers are allocated to schools and to classes within schools gives little opportunity for beginner teachers to interact with older more experienced teachers or for diploma holders to interact with teachers with a more secure knowledge base (see chapter four).

Science teachers in a Western context tend to have much more contact with scientific practitioners through degree programmes. Scientific knowledge is much more available in the West than it is in Tanzania through popular media. Because the system is not expanding it is not overwhelmed by new teachers. Such new teachers as there are may work as part of a year group team and have support from colleagues teaching the same topics. There will generally be an official or unofficial system of mentoring and sharing of ideas through teachers' associations. The scientific knowledge base is relatively easily maintained within the profession and added to by new teachers with exposure to science at university level and from the media. In contrast, the teachers in this study had very little access to knowledge of science and of scientific practice beyond textbook knowledge. The corpus of science teachers was rapidly being added to with more individuals with fragile content knowledge. Pathways by which new teachers could gain knowledge from more knowledgeable teachers or from practice were tenuous. The scientific knowledge base of the teaching community has not been sustainable due to the influx of new teachers without university level education.

New teachers may have extensive theoretical pedagogic knowledge as a result of the new diploma curriculum, but the focus on text-based knowledge within teacher training has limited teachers' tacit knowledge of pedagogy. There were few opportunities for trainee and qualified science teachers to work together and to exchange and develop pedagogic content knowledge. There was little opportunity for tacit knowledge about science and science teaching to be preserved within the teaching community by passing it on to new teachers; so science at secondary level appears to have been reduced to a body of codified knowledge contained in textbooks.

Low wages for teachers meant that many individuals who entered the profession saw it as a last resort (see chapter four section 4.1). The pay and conditions of service were considered to be very poor by the teaching community (see Kerr 2006). Teachers felt that their wage did not constitute a living wage and that they were justified in using school hours to pursue other money-making enterprises. This could have had a strong impact on pedagogy, as the time that teachers are willing and able to spend on preparation, teaching and marking may have been restricted. As contact time is reduced, the pressure to achieve coverage increases and teachers may resort to lecturing and giving notes to copy as a time saving device. The time involved in marking also provides a strong disincentive to set extensive homework problems. Practical work is time consuming to set up and this could go a long way to explain its near absence from observed school life. Many of the teachers that I worked with appeared to be well motivated and committed to their jobs. But a pedagogical culture appeared to have developed in which untaught lessons, lack of practical work and lack of homework had become accepted norms.

#### *Resource scarcity- equipment*

According to the common folk pedagogical model that emerged from the findings in chapters four and five, teachers did not treat practical work as a potential source of knowledge in the classroom or make many attempts to relate it to theory. However, conducting experiments was seen as a key element of good science teaching and many informants associated it with students gaining a better understanding of science. Teachers felt constrained by what they perceived to be a lack of the necessary resources for teaching science practically. However, when laboratories and equipment were present they tended to be very under-utilised.<sup>79</sup> One reason why teachers may not use laboratories even when they are available is that they lack technician support. This makes the setting up of practical work very time consuming for the teacher. It can be even more difficult for the teacher when there is no system for purchasing consumables, even readily available ones such as batteries and fuel.

---

<sup>79</sup> Bekalo and Welford (2000) make similar observations in Ethiopia. They found that very little practical work was done even when resources were present.



Large class sizes can make class practical work particularly difficult, but even demonstrations can be very labour intensive for a teacher to set up.

Resource shortages of the past may have had a significant influence on current teacher practice. The life histories of many of the teachers interviewed revealed that they had very little familiarity with practical work. Teachers' lack of familiarity with practical science made it difficult for them to determine when a specific piece of apparatus was vital or when it could be improvised or omitted from a practical. Given that the type of practical tested for in the examination tended to be very resource intensive, it was often the case that a school with some equipment was missing one or more of the items required. In such cases the teacher is unable to carry out the experiment even when most of the apparatus is available.

The teachers in this study tended to have very little experience of learning through practical work. For these teachers, knowledge about practical work in science was simply an additional area of theoretical knowledge. The theory of practical work was divorced from the tacit, uncoded knowledge of how to carry it out, how to make accurate observations and to interpret those observations. The tacit knowledge of how to carry out practical work has been lost from the teaching community through generations of teachers entering the profession without practical experience. The survival strategy of learning what the observations are according to the textbook had become part of the science classroom culture in the lessons observed. Even when apparatus was available, the textbook results were more valued than the experiential knowledge that students could gain from observation. Lack of resources in the past may have contributed to the elevation of text-based knowledge and the devaluing of experiential knowledge.

### **6.2.2. Scarcity of knowledge sources**

The teachers in this study, especially those in rural schools, had very few knowledge resources to draw upon. Their own exposure to and familiarity with scientific knowledge were often limited to that necessary to achieve a grade E at science A'

level. Some found themselves teaching in a school at which they were the only teacher of a subject. Even at larger schools, there was generally only teacher for the subject for a given year group. They therefore lacked opportunities to pool their fragile knowledge with other teachers. They also tended to have very limited experience of practical work and lacked opportunities to develop their own tacit knowledge through apprenticeship. The main knowledge resource beyond their own school knowledge was textbooks. Some teachers had access to a range of books, but with textbooks that do not follow the syllabus it may have been difficult for the teacher to judge which sections were relevant. The safest option was therefore to stick to the locally produced texts that were known to follow the syllabus or to the other 'standard' texts that were commonly known to be approved texts.

The scarcity of tacit knowledge has meant that much uncoded knowledge, or what Rowell and Prophet (1990) refer to as 'practical' knowledge, was not taught for or tested for. Tacit knowledge is learned through practice and familiarity. Acquisition of tacit knowledge is qualitative; it depends on how well the learner knows something. On the other hand, learning of codified knowledge can be done through memory and is more quantitative; it can be measured in terms of how much a learner knows. This may explain why teachers' models of learning in this study were mainly quantitative, with learners either knowing or not knowing, with little value given to practice as part of the learning process.

Take for example 'the scientific procedure' of hypothesis formulation, experimentation, data analysis and drawing conclusions. Within a Western setting teachers would have learned this through carrying out experiments and would teach it through getting their students to carry out the processes involved, either separately or together as a complete investigation. Recent science syllabi in Tanzania have included *the scientific procedure* as a topic to be taught early in form I (MoEC 1996a,b,c; MoEC 2005a,b). Few teachers would have had opportunities to carry out experiments that test hypotheses as the experiments within the practical examination rarely adhere to this sequence. The experiments in the practical examinations are mostly for identifying substances or measuring values rather than for investigating

relationships. Teachers may not possess the tacit knowledge of how to design and carry out an experiment to test a hypothesis. If so, they will have no incentive to develop this knowledge in their learners and no knowledge of how to do so beyond the codified definitions of each step and their sequence. Analysis of examination papers from 2003 and 2004, both practical and theory, revealed very few questions requiring students to use these skills, beyond heavily guided data analysis. A chemistry paper used as an internal examination in SESS schools tested students' knowledge in this area by asking them to list the steps in a scientific investigation in sequence but made no attempt to assess whether student knowledge went beyond the list of terms (SESS form III achievement test 2003).<sup>80</sup> The ability to list terms such as hypothesis, analysis and conclusion was tested, but the tacit knowledge of how to carry out these processes appeared to be absent.

### **6.2.3. Learning 'proper' science**

#### *Content of the Science Curriculum*

The question of what type of science education is relevant in Africa has been debated since colonial times and educationalists have often called for the science curriculum to be less academic and more applied, focusing on applications in agriculture and other 'appropriate' technologies. But attempts to make school science more relevant consistently met with local resistance (chapter two, Wedgwood 2003a). There have been numerous attempts to integrate local technologies into science education in Africa, but there has been little impact on mainstream science curricula despite the success of individual projects (see e.g. Lillis and Lowe 1987; Savage 1998; Spencer 2002). As discussed in chapter four (section 4.5), there is very little mention of local technologies and applications of science within the 1997 Tanzanian science syllabi and even less within the textbooks used.<sup>81</sup> One problem may be that teachers' content knowledge is not robust enough for them to apply their scientific knowledge to local applications such as brewing (see Knamiller, Osaki and Kuonga 1995). In a lesson on fuels, Mr Kiswaga (lesson observation 27/07/05) pointed out to the class that they

---

<sup>80</sup> SESS achievement tests are written by pooling questions written by teachers in SESS schools.

<sup>81</sup> The Mzumbe Book Project books are an exception here, but this project is externally funded and heavily influenced by foreign 'experts'. See chapter 2.

had seen charcoal made in the forest. He told them that it was made in the presence of a limited supply of oxygen, but made no attempt to ask or to explain how the oxygen supply was limited using the local technology. The syllabus and examination are both indicators and influences on the popular image of science and they tend to focus on academic science divorced from its applications in everyday Tanzanian life. The Ministry of Education guidelines for participatory teaching (MoEC 2004c), say that the teacher should link the learner's home knowledge with their school learning, but this is not possible when teachers have neither the ability nor the motivation to apply science to local situations.

Prophet and Vlaardinggerbroek (2003) consider a different aspect of relevance. They consider the match between the cognitive demands of the Botswana chemistry curriculum and the cognitive levels of students, measured according to Piagetian levels. Their findings indicated that there was a serious cognitive mismatch for certain science courses. This study draws on the work of Shayer and Adey (1981) that compared the cognitive levels of British secondary pupils with the cognitive demands of the Nuffield O' level science courses. The science curricula of many developing countries retained the highly academic content of courses like Nuffield, but lost the discovery learning approach (Ware 1992). As discussed in chapter two, the science curriculum in Tanzania was heavily influenced by Nuffield. The influence of Nuffield can be seen in the sequencing of topics in the 1997 Tanzanian science syllabi (MoEC 1996 a,b,c)

Shayer and Adey argued that many of the learning objectives of the Nuffield courses were beyond the learning capabilities of around 80% of school children in England and Wales. In the terminology used by Vygotsky (1934/1962: 103), many of the objectives were beyond most students' *Zone of Proximal Development* (ZPD). Many of the objectives of the 1997 Tanzanian science syllabi are the same as ones classified as requiring 'formal' thinking by Shayer and Adey (1981: 89); so a similar critique could be applied. Given the poor foundation that many secondary students had in Maths, English and Science, many of the objectives could have been well beyond the ZPD of most students; so that they were effectively inaccessible. This can encourage learners to employ the survival strategy of rote learning.

Many informants, including tutors, teachers and students, told me with pride that the Tanzanian O' level was equivalent to English A' level. It is true that much of the content of the Tanzanian O' level is only taught at higher levels in the UK. Calculations involving molarity and the use of quantum numbers to describe electronic structure<sup>82</sup> are some examples taken from Chemistry. Failure of most students to answer questions based on these topics was seen as a failing of the students or a failure of the system to provide the necessary teaching and learning resources. Informants rarely questioned the appropriateness of the curriculum except for expressions of concern about certain topics being left out.

The resistance to adapted, 'relevant' science curricula in the past also demonstrates how "proper" science is seen as a subject that should be very difficult. ZimSci and Unified Science were rejected on the basis that they were too shallow, and too simple for Tanzanian students (see chapter 2 and Hongoke 1997). This judgement was made in spite of the fact that failure rates in the separate sciences in Tanzania were very high, with under a third of candidates passing biology in 1995 (Malekela 2000). Parents and students preferred the high science represented by the separate sciences to the Unified Science curriculum that was designed to be more accessible. The drive to include "high science" in the curriculum has made it less relevant to learners both in terms of the cognitive demands and the abstract, alien nature of the content. If the curriculum is beyond the understanding and the experience of learners then it becomes virtually impossible to teach it in a way that incorporates students' own knowledge into the learning process. Participatory methods may be inhibited by the high cognitive goals of the curriculum and its lack of local relevance.

#### *Practical science*

A further mismatch between the curriculum and classroom reality is the expectation of the type of practical work that should be carried out in schools. As mentioned in chapter five, the resources requirements of the curriculum were very high. Use of locally made alternatives for science apparatus was encouraged in the teacher

---

<sup>82</sup> The form II chemistry syllabus states that students should use K,L,M,N to refer to electron shells. In Ethiopia the level expected is even higher with 13 year-olds expected to give electronic structures of the first 30 elements in terms of s,p,d, and f orbitals (Engida 2002).



training curriculum, but interviews revealed that many science teachers felt that they needed purpose-made materials to teach science properly. Many informants espoused the use of locally made materials and yet retained the belief that proper secondary science needed to be taught using expensive equipment. Mr Massawe, a science curriculum developer, had worked on the Mzumbe Book Project, which promoted the use of local materials for science education (see chapter two). During an interview he extolled the use of locally made alternatives to expensive imported equipment. However, when asked whether the science curriculum should be adapted to take into account the fact that many schools did not have access to expensive equipment, he justified the current form of the curriculum by arguing:

Poverty has no options. Schools must have equipment. Nothing good can come out of extreme poverty. You can't have syllabuses that assume that schools do not have apparatus. You assume that the schools have the apparatus then it is the obligation of the schools to buy the apparatus. So the syllabus assumes that there will be apparatus, it assumes that schools will have burettes. If there is no equipment then it is the responsibility of the school not of TIE.

(Mr J. Massawe, Science Curriculum Designer, TIE, 27/06/05)

Like other educators, he felt that the national syllabus should reflect proper, modern science and not the poor man's alternative. He went on to explain how the new curriculum had combined chemistry and physics as a "soft subject" that all schools could afford to teach, as it was less resource intensive than the old syllabus. Box 6.1 below gives some of the materials listed in the new syllabus for the first year of the course.

**Box 6.1 Materials listed in first year Physics with Chemistry syllabus (MoEC 2005a)**

Ammeter	Beam balance	Density bottle
Magdeburg hemispheres	Spring balance	Combustion spoon
Vernier callipers	Pan Balance	Beehive shelf
Micrometer screw gauge	Eureka can	Delivery tubes
Thermometer	Microscope	Wall pictures of X-rays
Pipette	Smoke cell	High power tensions
Burette	Distillation apparatus	Foam extinguisher
Measuring cylinder	Centrifuge	Carbon dioxide extinguisher

Inclusion of some of the more obscure, expensive equipment, such as Magdeburg hemispheres and a centrifuge, means that virtually no schools in the country would have the recommended materials. Almost all teachers would be in a situation where they were not able to use the materials recommended on the syllabus. Given that the ideal in the syllabus was unattainable in most schools, it would be easy for teachers to assume that their schools were insufficiently equipped to teach using practical demonstrations and to give up any attempt to carry out the activities recommended. By recommending such materials, the syllabus delivered an implicit message that 'proper science' can only be taught practically with expensive, specialist materials. As these materials were unavailable in the majority of schools the curriculum effectively sanctioned the teaching of science through theory alone. Teachers may have become used to delivering only the minimum possible of the practical element of the syllabus. Ignoring the suggested activities of the syllabus appeared to be accepted practice in the lessons observed. The image of science sustained by the curriculum exacerbated the resource shortages as it left schools and teachers in a constant state of being under-equipped. This may have helped to strengthen the perception of teachers that they were unable to teach practical science due to resource scarcity. Teachers had learned to cope with a curriculum that assumed the use of expensive equipment by teaching about practical science theoretically. Learning through experimentation and observation was rarely experienced within lessons and so the binary model of learning through inputting codified material was reinforced.

#### **6.2.4. Learning through English**

Use of a second language (or third in the case of English) as the language of instruction can inhibit understanding and encourage rote-learning styles (Prophet 1988; Arthur 2001). Comparisons of lessons taught through English medium and Kiswahili medium (Mwinsheikhe 2003; Brock-Utne 2005; Mwinsheikhe and Vuzo 2005) indicate that enforced use of English in the classroom reduces student participation in the classroom and results in a lower quality of learning, as indicated

by test scores.<sup>83</sup> The class discussion in Miss Muna's biology lesson (see section 5.2.6) demonstrates how allowing students to use Kiswahili can encourage participation. The English medium policy could therefore be seen as directly antithetical to participatory methodology, as it reduces students' ability and confidence to participate in classroom discussions.

The English medium policy may also have had more indirect, far reaching effects on pedagogical culture as it helped to reinforce the image of the sacred text and the reliance on rote learning for survival. This in turn may have reinforced the binary model of learning. The insistence on the use of English in a context where neither teachers nor students had a high level of fluency meant that teachers and learners had very little capacity to alter or rephrase texts. This led to the conservation of text in its verbatim form. When a piece of text, such as a definition, becomes widespread through conservative replication, it can gain authority through popular acceptance. The more widespread that a definition becomes, the more unassailable and sacred it will be in its verbatim form. Take the case of the definition of growth in Mrs Chambulila's lesson (see chapter five, section 5.1.1): all groups produced virtually the same verbatim definition as a result of what was supposed to be group discussion. Where there were small deviations, groups corrected these to conform to the common wording from other groups. If one group had produced an alternative definition it would have appeared wrong on the basis that it differed from the consensus. Students' and teachers' lack of fluency in English meant that the validity of a definition was more likely to be judged on its conformity to the majority than on its meaning. If Mrs Chambulila's form of the definition had not been as widespread it would have had less authority and she might have had more need to justify its validity against alternative definitions derived by the groups. The limited range of textbooks available in the past may also have contributed to the conformity of the sacred text as the range of original sources is limited.

---

<sup>83</sup> A similar situation exists in francophone Africa. Gado and Sunal (2004) found that use of French medium of instruction in Benin was a barrier to the introduction of inquiry based science teaching and encouraged rote learning among students.

The use of English appeared to inhibit the teachers' ability to link school science with students' everyday experiences. As noted in chapter five, there was a tendency for teachers to use Kiswahili when asking about every day applications of science. This may have been because students' English vocabulary was limited to textbook science and they could not easily discuss home life in a language that was almost never used in this domain. It could be argued that the English medium policy has helped to maintain the separation between science, which is carried out in English, and everyday life which is carried out in Kiswahili.

Teaching science through English makes it more difficult for learners to understand. This may increase the cognitive mismatch between the learners and curriculum and make it more likely that learners will resort to rote learning as a survival strategy. Even if students' English language skills improve significantly during their four years at secondary school, low quality learning during the early stages due to lack of fluency in English could mean that students have already developed a habit of relying on rote learning. Poor comprehension in the early stages of secondary science may make it difficult for learners to apply foundational concepts, such as kinetic theory, to topics that they meet at a later stage. Many teachers may have experienced a situation during their own education where their understanding of science was inhibited by the use of English, encouraging reliance on rote learning. Teachers who have themselves relied on rote learning are more likely to have a binary model of learning, as their own experience of learning would often have involved one stage memorisation.

Given the longer-term indirect influences on pedagogy that the medium of instruction may have, and combined with the other pedagogical outcomes of the image of modernity, changing the medium of instruction to Kiswahili is unlikely to bring about a dramatic change in pedagogy in the short term. As mentioned in chapter two, pedagogy in primary schools was far from participatory, in spite of the use of the Kiswahili medium. English medium alone cannot account for the preference for conservative knowledge transfer over knowledge construction within secondary science classrooms.

### **6.3. Potential for change**

#### **6.3.1. Escaping the sacred text**

Although in many cases teachers applied the ideas of participatory methodology in form rather than essence, and the teaching learning process remained a transmission of a sacred text, some teachers, notably the younger ones, demonstrated methods that were successful in taking learning beyond the rote memorisation of definitions and laws. The following examples of teaching practices that were mentioned in the previous chapter show potential for helping the learner go beyond the sacred text and allowing more meaningful learning to take place.

##### *Direct translation of terms*

The first practice is the direct translation of single terms into Kiswahili. As discussed above, the use of English medium in schools has contributed to the establishment of a pedagogical culture in which the verbatim recall of texts is valued over understanding and application. However, the symbolic power of English medium education as a pathway to becoming modern makes it highly unlikely that the language policy will change. Working within this system, teachers tended to resort to code switching. However, it was done in such a way that Kiswahili was associated with procedural or daily life knowledge that was to be understood and acted upon, but was of little value. English, on the other hand, was used for knowledge of high value that did not need to be understood or acted upon. Hence the type of code switching observed in many schools helped to elevate the sacred text further. The direct Kiswahili translations for terms as provided by Mr Kiswaga, Miss Muna and Mrs Kyembela helped students to increase their English vocabulary and to link what they were learning with knowledge from outside the English medium classroom. By providing direct translations of terms, teachers can help to separate science from English. The concept is developed as something independent of its verbal tag. Learners realise that what the teacher is talking about is not something new and mystical but something they already know about, albeit in a different language. Mrs Kyembela's provision of translations was limited to giving the Kiswahili word after



using the English word in addressing the class. Mr Kiswaga and Miss Muna were more structured in providing their translations, they asked the class to give the Kiswahili words for the terms used. Mr Kiswaga gave the most explicit translations by writing the terms on the board.

There may be many cases where Kiswahili does not have a directly equivalent word, as illustrated by the term “*yeyuka*” which means both to melt and to dissolve. In other cases equivalent Kiswahili terms exist but are as unfamiliar and ‘foreign’ to teachers and learners as the English terms (Kadhege 2003). Where these cases arise, a brief explanation or exemplar of the term in Kiswahili may give more understanding of the concept than a definition in English. Policy in most schools demanded that teachers use only English in class. Encouraging teachers to use Kiswahili in a careful, structured way to provide translations of terms could help to increase meaningful learning of both science and English.

#### *Competition*

As described in the previous chapter, establishing an element of competition into classes increased student involvement and, in the case of Mr Rhamadani’s lesson on drugs, encouraged students to critically evaluate each other’s contributions. Competition introduced an incentive other than the examination. The authority no longer resided with the set text that would be accepted in the examination but with the students themselves who had the opportunity and the motivation to argue the case for their points being accepted and for the other team’s points to be rejected.

#### *Standing Back*

Miss Muna’s method of teaching by providing the class with questions to research for homework then standing back in the class while they presented and discussed their answers was successful on many counts: it fully involved students in classroom discussion; it encouraged them to contribute their experiential knowledge to discussions and it was very popular with students. There are many elements of Miss Muna’s methodology which contributed to the success of her strategy, including the fact that she allowed her students to use Kiswahili and also that she set them the research task as homework several days before the lesson. What was notable about

the lesson was that she took a very low profile position in the classroom and in the discussion. She stood at the back of the class and her contributions were limited mainly to prompting students to ask each other questions, providing answers herself only when the students were unable. The answers that groups gave to the questions set for homework tended to be very close to the sacred text; with students giving definitions when asked to give explanations. However, by encouraging inter-student discussion and critiquing of each group's answer, the teacher managed to establish an atmosphere in which the definitions were explored and elaborated on and students began to link the ideas to their knowledge from outside school. By standing back and letting the students discuss with each other, the teacher gave space for discussion that went beyond repetition of the sacred text.

### **6.3.2. Introducing more practice based, experiential learning**

The three techniques discussed above all showed great potential for improving learning within Tanzanian science classrooms, but it should be noted that they are all essentially verbal, getting students to participate orally. The elevation of the status of the text has helped to suppress the value of practical knowledge, that is the skills, familiarity and understanding of science needed to carry out and interpret experiments and to solve problems. As discussed in chapter five, students were given very few opportunities to develop their practical, problem solving skills. This may be partly due to the binary model of learning discussed, but is also dependent on teachers' professionalism and willingness to devote extra hours to marking written work. Teachers tended to see themselves as underpaid and it was common practice to use school time for other private money making activities (see Kerr 2006, Stambach 2000, Anangisye 2006). Given this culture, it is unlikely that teachers would be willing to spend time outside school hours to mark homework. The examination system also favoured recall of information rather than practical skills. As most students scored below 40% and this could generally be attained through recall alone, it was pragmatic to focus on information acquisition rather than on skills acquisition which is more time consuming for both the teacher and the student.

The term “drill-and-practice” is often used to describe what is considered to be outdated and low quality education in the same way as the term “chalk-and-talk” is used. In the lessons that I observed, there was a great deal of talk (though this was not always teacher dominated), some chalk, but very little drill or practice beyond the repetition of the sacred text. More drill and practice in science education means more work for both students and teachers; so it is unlikely to be a popular pedagogical intervention, but it would give more opportunity for students to develop their thinking skills through problem solving and enhance science learning.

#### **6.4. Conclusion**

The model presented in figures 6.1 and 6.2 provides an interconnecting set of explanations for the pedagogical culture observed. Addressing any one aspect of the influences on pedagogy (e.g. equipment, textbooks, teacher training) is unlikely to have a far-reaching effect due to the complexity of the interactions. Most of the causal linkages suggested are also relevant to other country contexts, which explains why many of the pedagogical traits described are found in other countries in Africa and elsewhere. The Tanzanian case is an extreme one because the distance between the image of modernity and the everyday experience of most teachers and students is especially wide. The model illustrates potential dangers in trying to “run while others walk” or trying to leapfrog ahead in development. The alternative approach of adapting education to the context risks stagnation and, more critically, is likely to be highly unpopular as it goes against the image of modernity.



## 7. Conclusions

This study had its origins in a situation of intercultural incomprehension. In the introduction, I related three cameos that exemplified situations in which I saw Tanzanian educators' pedagogical actions as irrational, or in which they saw my recommendations for change as equally irrational and ridiculous. The thesis has attempted to explore why Tanzanian teachers' actions are rational within the cultural context in which they work. Elucidating the rationality of Tanzanian teachers' actions has necessitated and facilitated a critical analysis of the rationality of Western pedagogical models and the assumptions on which these models are based. In this final chapter I consider the answers to the research questions stated in chapter three and the directions for further research indicated by the findings.

It is argued that the predominant pedagogies that were found are rational within a context of information scarcity. Knowledge was treated conservatively and the teaching-learning process was largely concerned with the transmission of this knowledge to the next generation. These pedagogical approaches are similar to those found in oral societies and can also be seen as an expression of a communal culture where all learners share a common knowledge source. As information sources become more abundant, pedagogical approaches favoured in the West become more rational. The problem within the Tanzanian context is that attempts to imitate the West have exacerbated the information scarcity and perpetuated pedagogies based on the reproduction of knowledge. These local folk pedagogies are contradictory to Western constructivist models of learning, and may explain the limited impact of intervention measures.

A relativistic response to these findings might be a deliberate attempt to perpetuate indigenous pedagogies and to resist efforts to import Western pedagogies. Such an approach to educational change, like policies of adapted education, takes a static and isolated view of Tanzanian culture and ignores the profound influence of local images of modernity. We cannot juxtapose the local culture and Western culture when the apparent local culture is to aspire to the popular perception of modernity as modelled by Western culture. Local pedagogic culture is as much a product of this



image of modernity, derived from Western models, as it is of traditions dating back to pre-colonial times. I argue that participatory methodology, or *njia shirikishi*, whilst influenced by European thinking, is an indigenous modern pedagogy.

Tanzanians' association of modernity with Western academic culture has proved highly problematic and, arguably, has inhibited the development of more meaningful learning of science. The assumption that Western pedagogical approaches are desirable, effective and modern is challenged by the high achievement of scientific literacy in many Pacific rim countries where the teaching style tends to be more teacher centred and less individualistic. Eastern pedagogical approaches may provide an alternative to Western pedagogies within African contexts as there may be greater cultural congruence. It is suggested that Africa-Asia comparisons of pedagogy would provide a fruitful line of further research.

### **7.1. Folk pedagogies: rooted in tradition but sustained by the pursuit of modernity**

In chapter one I discussed how teachers' knowledge about how to teach and what to teach is informed by their personal understandings of the nature of the material being taught and the learning process. The pedagogical culture is shaped by the shared local knowledge about science and learning science. In this study I sought to answer the question: What do tutors, teachers and students see as good science teaching (folk pedagogies)? To answer this I have attempted to identify the types of knowledge and learning that educators aim to promote in science education (folk curricula) and the models of learning that guide their practice (folk psychology).

The findings presented in chapters four and five show that many of the teachers within this study saw teaching science as a process of delivering a set body of knowledge. Definitions featured prominently and were seen as key to understanding the material covered. The science curriculum was treated as a sacred text, a body of codified knowledge that should be studied and reproduced in its verbatim form. Other forms of knowledge such as experiential knowledge outside of the school curriculum and the tacit knowledge developed through practice of solving problems

and application of scientific laws and principles were rarely acknowledged. Little effort was made to access experiential knowledge and few opportunities were given to students to develop scientific thinking skills through solving problems requiring thinking beyond recall.

If the knowledge to be learned in schools is a set body of text, it is rational to focus on the transfer of that text rather than on the development of tacit, uncodified knowledge (skills). Since knowledge of the text appeared to be the most important aspect of the folk science curriculum, learning science was generally equated with memorisation of the text. This was seen as a one step process, students either 'had the concept' or they did not. If students failed to get the concept then the teacher would repeat it. Verbal recitation of the text (e.g. of definitions) was taken as evidence that learning has taken place.

If it is assumed that my former Tanzanian colleagues shared the model of learning and curriculum found to be predominant among the teachers in this study, their actions described in the introduction, which at the time appeared to be irrational, can now be seen as rational. The maths teacher was behaving rationally when he prioritised the learning of the list of rules for compass constructions over the skill of using the compass. The codified rules were seen as a more important part of mathematical knowledge than the tacit, uncodified skill of compass manipulation. My Kiswahili teacher's approach to teaching me was rational if learning Kiswahili is seen to involve covering a set body of knowledge, as outlined by the curriculum from primary school up to the university level. As I had not studied Kiswahili formally before, it was obvious to him to start at the beginning of the primary school syllabus. The knowledge of Kiswahili that I had learned through living there was not valued within the classroom context. My fellow chemistry educators' rejection of the idea of a spiral curriculum was a rational one within a paradigm that sees learning as the acquisition of a sacred text. If learning just involves the inputting of the text then there is little sense in repeating the process or leaving out certain details the first time and then repeating it with the details added a second time. The strong desire for conformity, for all learners to cover exactly the same material, is also symptomatic

of a view of the curriculum as a set body of text. This could explain their resistance to the idea of using a circus of experiments.

The sacred text can partly be seen as an expression of communality over individualism within Tanzanian culture. In communal cultures it is important that all members share the same knowledge, whereas in individualistic cultures, personal meanings and interpretations of the knowledge are seen as having greater value. My fellow chemistry educators were concerned that using a circus of experiments would lead to different students learning different things. Similarly students were concerned that a teacher teaching without notes would teach different things to different classes (see section 4.6). Mr Mfikwa was concerned that if he used his own knowledge of good manners and hygiene he might go 'off topic'. Informants generally saw it as important that all students were taught the same script. Some teachers claimed that they were confident that the whole class had understood based on oral answers from a minority of individuals. If the class is treated as a communal whole then correct oral answers from a few individuals shows that the class has acquired the knowledge. This communal approach to teaching and learning is closer to the Asian cultures of learning than the Western ones where the personal knowledge of individual students is seen as the basis for learning. As mentioned in chapter one, Asian countries often out-perform Western countries in international achievement tests. Western agencies' assumptions about 'good science teaching' may be partly based on cultural values of individualism, and not simply on evidence of the teaching methodologies that lead to better learning outcomes.

Chapter one explored aspects of oral cultures that were contrasted with literate cultures in the academic literature. Many of the approaches to knowledge and learning described for purely oral societies fit with those observed in this study. In oral societies, utterances are memorised in their complete forms. Words are inseparable from the concepts that they denote, just as verbatim forms of the definition were treated as inseparable from the concepts that they described in the lessons observed. Ong (1982/2002) and Olson (1991; 1996) argue that it is only with

literacy that analysis and originality begin to be valued over replication and conformity.

It was argued that these two states of orality and literacy should not be seen as a binary system, since many characteristics of oral culture can be identified within societies with high levels of literacy. Instead they could be viewed as positions along a continuum that stretches from situations in which there is very limited access to information to systems in which there is almost an overabundance of information. The way that a society treats knowledge, hence the way that it teaches its children, will depend on that society's position along the continuum. Literacy marks a significant leap along the continuum by enabling exchange of information between individuals to take place without those individuals coming into contact. It facilitates interchange of knowledge between regionally separated societies and between generations. It increases the storage capacity of information beyond the memory of individuals so that the society as a whole has access to a much greater pool of knowledge. It may also facilitate objectivity by separating words from their interpretation. However, not all knowledge can be codified. The position along the continuum will also depend on the level of access to personal, tacit knowledge that is passed on through apprenticeship, or learning on the job, rather than direct transfer. A critical mass of expert practitioners is needed for this tacit knowledge to be sustained within a society.

The folk pedagogy of the sacred text and the binary model of learning are symptomatic of a context in which there is a scarcity of information sources. Tanzanian science education has developed in such a context. This is not to deny the presence of rich indigenous knowledge systems. But for science teachers, who are working to promote the culture of Western science to their students, the Tanzanian context remains one of information scarcity. Within a Western context there is an abundance of information relating to scientific culture and the knowledge system of science. There is a profusion of books, science programmes, web-based sources, and, most crucially, teachers who have had extensive contact with modern scientific culture through their own education up to the degree level. Western science teachers



learn science through cultural immersion and not just through textbooks. They are therefore equipped with a rich body of tacit knowledge to support their codified knowledge. Where there is a great abundance of knowledge, the problem becomes not how to access knowledge but how to trust it; how to choose between one source and another. Recall of information is not highly valued as the information is readily available. The job of the knowledge seeker becomes one of analysis and verification not of collection. This empowers the knowledge seeker to question the knowledge source. The authority is with the learner and not with the knowledge source.

In contrast, the science teachers in this study worked within a context of information scarcity. In some schools there were critical shortages of textbooks and other written sources of information. But what may be more significant is that teachers lacked exposure to the culture of Western science. Their knowledge of science was almost entirely derived through poorly understood textbook based teaching, delivered by teachers who themselves have had very little contact with the scientific culture that they aimed to teach. The tacit, skills-based elements of scientific knowledge have been eroded away and lost, leaving only the textbook based knowledge. This limited knowledge source was treated as absolute as teachers did not have the authority to question it or to reformulate it. Because the information sources were scarce, they were treated conservatively rather than critically. Memorisation, or 'possession' of the information was more important than its use and analysis. Analysis was dangerous as it risked corrupting the information or losing it. Because the tacit dimension had been eroded away, skills were not valued and little attempt was made to develop them.

A similar pedagogical culture might arise if British schools were to attempt to teach Maasai culture based on only a handful of text based sources and with a teaching cadre that had never experienced Maasai culture for themselves. The resulting pedagogy would rely largely on the replication of the limited text sources and what students learned would be a very poor and incomplete image of Maasai culture. Students would learn about the exotic rituals but would not learn the meanings behind them or the skills necessary for carrying them out. For Tanzanians studying



science, the foreignness of science makes it appear like a strange ritual. Just as with some Western ethnographers of African cultures, was a tendency among the science teachers in this study to focus on the more exotic and esoteric aspects of science rather than on the underlying principles. Mundane aspects of science and aspects found in local, everyday life were overlooked as they did not fit with the exotic image of modern science.

However, the pedagogical approach of my Kiswahili teacher is not so easily explained in terms of information scarcity. What this cameo does clearly illustrate is the separation of the academic form of Kiswahili from the day-to-day use of Kiswahili. This separation is the same as the separation between academic science and local, indigenous science. Tanzanian teachers clearly have access to extensive knowledge about day-to-day Kiswahili, just as many teachers would have access to indigenous knowledge about science such as farming techniques or local medicines, but the society lacks access to academic forms of these knowledge areas. Kiswahili in schools is seen as part of the academic culture, based on a Western academic tradition. The strong desire to follow Western academic studies and the rationale behind that desire were discussed in chapter two. The 'academicization' of local knowledge is a result of the desire for modernity and the equation of modernity with Western cultural practices, as discussed in chapter six. Tanzanian societies have limited access to Western academic culture even when it is applied to indigenous subjects such as Kiswahili. Indigenous subjects have been made alien through making them academic and this has reduced the access to them.

The educational history of Tanzania demonstrates that Tanzanians have generally tended to favour academic science in the form of chemistry, physics and biology, over applied courses such as agriculture. Throughout colonial and post-colonial times, policy makers have attempted to make the curriculum more relevant through the inclusion of agriculture and through the inclusion of some mention of local technology in the syllabus, but these have generally been unpopular. Teachers and textbooks make few references to local applications of science. The science that is generally promoted is 'high' science involving complex laboratory practicals such as

titrations, qualitative analysis of inorganic compounds or chemical tests to identify different food types. Some donor funded projects and the teacher training syllabus have promoted the use of local alternatives to expensive laboratory equipment, but informants demonstrated a strong belief that real science must include knowledge of how to use equipment such as burettes and pipettes. Although the science syllabi include elements such as hygiene and HIV/AIDS prevention, the inclusion of these subjects in the curriculum has generally been supported by external donor funding and expertise.

The desire to imitate Western culture is a symptom of the post-colonial state. Tanzania is within an intermediary space that, according to Mudimbe:

...reveals the strong tension between a modernity that is often an illusion of development, and a tradition that sometimes reflects a poor image of a mythical past.  
(Mudimbe 1988:5)

For Tanzanians, the image of modernity involves learning 'high' science and learning in English. But as Mudimbe states, this image of modernity is often an illusionary one. The type of science that the curriculum aims to train students in is only an image of the science that takes place, or once took place, in a minority of Western schools. It is an image based on the English grammar and public school education of colonial officers and early expatriate teachers. This intermediary space leads to a wide gulf between aspirations, based on an image of the West, and reality in which there is a scarcity of information sources relating to the modern culture that society aims to emulate. The aspiration-reality gap was discussed in chapter four with relation to the gap between the activities suggested in the teacher training curriculum and the practicalities within the college and the schools. It was also seen in chapter six where the resource requirements of the new *Physics with Chemistry* syllabus are listed. It is further exemplified by the policy-practice gap with the English only policy in schools and the actual practice where very little of secondary school life takes place in English.

As discussed in chapter six, the desire to achieve modernity has exacerbated the information scarcity, through high resource requirements, recruitment of teachers without robust content knowledge and through the English language policy. If we take the pedagogical model of the replication of a sacred text to be symptomatic of information scarcity then it can be argued that the pursuit of modernity has strengthened it. Scientific skills such as analysis, observation, experimentation, and application of theories and models were not promoted due to the predominance of the sacred text within classroom culture. The pursuit of modernity has inhibited the attainment of scientific literacy, one of the goals it sought to attain. Tanzania, like many other African countries, remains trapped in the intermediary space, as the pursuit of an image of modernity through education can be seen as hindering the development of a pedagogical culture that would lead to more globally valued learning.

## **7.2. *Njia shirikishi* as a modern indigenous pedagogy**

The second question in this research was: how have local folk pedagogies influenced the adaptation and adoption of Western teaching methodologies to give the concept of *njia shirikishi*? As described in chapter two, and demonstrated in chapter four through the prominence of the VIPP cards in the teacher training syllabus, *njia shirikishi* is a local amalgam of ideas from European mainstream education based on constructivist models of learning and participatory training methodologies modelled by development agency-led workshops. Because of this amalgamated nature of *njia shirikishi*, it is difficult to identify exactly what it is. We see different levels of interpretation of the idea at the different levels of policy and practice. Whilst the Ministry's "*Mwongozo wa Kufundishia kwa Kutumia Njia/Mbinu Shirikishi*" [*Guidelines for teaching using participatory ways/methods*] stresses the importance of students' knowledge from the wider environment, there was almost no acknowledgement among the teachers and tutors in this study of students' *experiential* knowledge. Teachers recognized the importance of students' prior knowledge, but the knowledge sources that they described were text based ones (primary school syllabus, the notes of fellow students, books). At the practitioner

level, *njia shirikishi* was seen as a teaching methodology that attempts to involve students in the activity of sharing and passing on an authoritative body of text-based knowledge. Student exposure to the text-based knowledge was therefore seen as a prerequisite for participatory teaching and learning to take place.

As discussed in chapter four, the list of participatory teaching methods given in the course materials for the “curriculum and teaching” course of the diploma appears to be linked more to images of modernity (e.g. film shows, demonstrations) than to constructivist and/or co-operative models of teaching and learning. And conversely, teaching methodology linked to traditional/ non-modern learning (story telling, songs) were judged as non-participatory despite the fact that they could potentially be used to involve all the students. *Njia shirikishi* was seen as a modern teaching methodology involving new technologies that made ‘traditional’ methods redundant.

Many teachers in this study used the language of *njia shirikishi* to explain their actions, even when their teaching style did not differ greatly from that of teachers who had not been exposed to the idea. Class question and answer sessions described as “participatory” by young teachers who had passed through the new diploma curriculum differed very little from the question and answer sessions carried out by untrained teachers or by teachers that had trained under the old diploma curriculum prior to the introduction of the term. For some of the teachers, any oral questioning was seen as participatory teaching methodology. But many teachers saw group work as more participatory than whole class teaching and some had adopted this as a teaching methodology. Within the local interpretation of *njia shirikishi*, group discussions were about pooling information and knowledge resources rather than contributing personal understandings and negotiation of a consensus.

When teachers’ practice and their rationales are compared with the policy level descriptions of participatory methodology, and the Western ideas about constructivism and learner-centred teaching on which these are based, it could be argued that many of the teachers in this study had taken up the form of the new pedagogical ideas without taking up the substance. Like many South African teachers trained in learner-centred teaching (Brodie, Lelliott and Davis 2002), they

had adopted teaching techniques such as group work, without changing their fundamental beliefs about the knowledge that children have or the learning process. But this assumes that *njia shirikishi* was the same as the pedagogical model promoted by the Swedish and Finnish educators. *Njia shirikishi*, it could be argued, was an indigenous model of pedagogy. It involved ideas imported from elsewhere but had been reconstructed by the Tanzanian educators promoting it. In the previous chapter I explained how the race for modernity had given rise to a pedagogic culture that conflicted with Western models of pedagogy based on ideas of constructivism and learner-centred teaching. To resolve this conflict, Western pedagogical models, imported through TEP, appear to have been adapted to create an indigenous concept of *njia shirikishi* at the practitioner level.

What *njia shirikishi* does appear to have challenged is the idea that the teacher is the central authority as a knowledge source. Chapter one mentioned how research into African pedagogy often describes the authority of the teacher as a barrier to the adoption of learner-centred teaching techniques. Some argue that this was because the role of the teacher was equivalent to that of the elder and so the teacher should not be questioned. Jansen (2005a) points to the fragility of the teachers' authority as the barrier, arguing that their authority as a knowledge provider in the classroom was virtually the only authority they had and so they could not afford to hand it over to the learners. These findings show that the authority of the teacher has not been a major obstacle to the adoption of *njia shirikishi* among the teachers interviewed. Teachers had enthusiastically adopted the idea that the student can be an important source of knowledge, and that students bring knowledge with them to the classroom. This is not to deny that teachers still maintained a strong authoritative role in the school in general. Staffrooms often had a selection of sticks, and beating pupils for lateness, low marks or failure to carry out cleaning duties were common aspects of school life. But the teachers did appear to have submitted some of their authority as an unquestionable source of knowledge in the classroom. They invited questions from the class and students raised them. Teachers would frequently hand these questions back to the class and the strongest adopters of *njia shirikishi* would admit to a class when they did not know an answer. However, student contributions were still judged against their conformity with the text. Whilst the authority of the teacher



may not have been an obstacle to the adoption of learner-centred pedagogies; the authority of the text remained a barrier. *Njia shirikishi* can be seen as an adaptation of learner-centred teaching in which the learner has the authority to question the teacher but not to question the text.

The teachers interviewed in this study generally demonstrated a willingness to accept the new role of the teacher as a facilitator rather than as a knowledge source. This acceptance might partly be due to an acknowledgement of the fragility of their own subject knowledge. Teacher knowledge was considered by trainees to be a very important quality of a good teacher (see section 4.3.2). The high value with which they held it may indicate that they had often found it lacking in their own teachers. If the teacher's role becomes one of facilitating knowledge transfer, rather than being a knowledge source, teachers may feel relieved of the responsibility of knowing. This could help to reaffirm teachers who do not feel secure in their subject knowledge.

The case of participatory learning methodology shows how 'modern' teaching methodologies can be adapted in order to carry out traditional reproductive teaching. The symbolism of modernity was present, but the underlying folk pedagogy remained unchanged. Participatory methodology differed from previous imports of pedagogy in that, whilst many of the influences have been Western (donor facilitated training workshops, Swedish and Finnish educators) the actual construction of the concept of *njia shirikishi* has been an indigenous one. It cannot be compared with the development of SSP in the late 1960s where most of the writers of the teaching materials were non-Tanzanian (see chapter two and Wedgwood 2003a), or with unified science (Hongoke 1997). Both these curriculum interventions challenged the nature of the curriculum and the sacred text. Both attempted to make science more relevant and less academic, and hence challenged the image of science as something belonging to an exotic, alien, but profoundly modern world. *Njia shirikishi*, as adopted by practitioners, enables the sacred text to be maintained whilst appealing to the sense of modernity.

### **7.3. Culture and pedagogical change**

Given the mismatch between Western pedagogical models and the pedagogical models of the Tanzanian science educators within this study, it might be argued that greater efforts should be made at the level of policy and curriculum to adapt teacher-training initiatives to fit more closely to the local culture. As discussed in chapter two, the pathway of adaptation is a flawed one. It assumes that culture is static and unchangeable. Klitgaard (1994) gives a useful analogy through which the role of culture in development can be taken into account. Culture, argues Klitgaard, is like soil. For optimum results a farmer needs to know his soil, he needs to know what crops grow best and how to treat it. In other words he needs to know how to adapt his choice of crop and cultivation method to suit the soil. But a good farmer is also capable of changing the soil, by adding fertilisers, water or loam. Different teaching methods will thrive best in different cultures. But, just as a farmer can diversify if he treats his soil appropriately, societies should not be restricted to the traditional pedagogical approaches; the culture can be changed to accommodate different approaches to teaching and learning. The spread of *njia shirikishi* through the TEP and the diploma course appears to be altering the culture, in terms of the authority role of the teacher and the capacity of students to contribute to the learning process. This may have enabled more learning to take place through group work and peer teaching (see below). Taking Klitgaard's analogy further, the crops themselves may have an influence on the soil; legumes add nitrogen to the soil, plants can improve the soil's texture. Likewise the cultural medium in which education occurs is itself changed by the education that takes place within it. As more members of a society become educated in science, scientific knowledge will become less scarce and this may alter the way in which it is treated. However, for this to take place in Tanzania, the quality of the science learned, in terms of the depth of understanding, needs to be increased and not just the quantity of people who are able to replicate a set scientific text.

The time span of cultural changes may be much greater than the average project implementation-evaluation cycle of donor-funded interventions. Chapter one discussed theories of how literacy changes the way that a society treats learning and

knowledge acquisition. But writers such as Ong (2002) point to the long lasting residual influence of orality. One of the residual effects that Ong discusses is the reverent treatment of texts. Ong's theory fits well with the observations discussed in chapters four and five of the importance of verbatim definitions and the sacredness of the text. With regard to students' and teachers' use of libraries, it would appear that provision of books has not brought about an instant change in the way that Tanzanians access and treat knowledge. Within secondary school science the official texts remained sacred and other texts were not highly valued. The style of examination questions, and fear that answers that diverge from the text will not be awarded marks, have helped to slow the rate of change and maintain the conservative treatment of knowledge, as deviation from the set text risks loss of marks. The use of English medium has restricted access to untried knowledge sources and so has also acted to preserve the sacred text.

Even if students gain access to new texts, what means has the community of educators of verifying these texts without reference to the old, accepted and revered texts? Teachers need a personal, tacit knowledge of science if their scientific knowledge is to go beyond replication of texts. They need access to the culture of science as well as the codified knowledge describing it. Schooling will remain based on the reproduction of texts while the culture that schools attempt to promote in their learners is one that neither teachers nor learners have access to.

The third question guiding this research was: what teaching approaches work to the extent of involving students in quality learning? As discussed in chapter three, I do not believe that, as an outsider, I have a remit to recommend changes to teacher training or teaching practice, but a potential outcome of the research is the sharing and promotion of successful teaching techniques displayed by individual teachers. In chapter six I gave three examples from the lesson observations of teaching techniques that have potential for leading to more meaningful learning within the current context; namely direct translation of terms into Kiswahili, classroom competitions and standing back while students present their own solutions to problems, as exemplified by Miss Muna. Direct translation of terms into Kiswahili, it

was argued, helped students to connect what was learned in primary schools with the secondary school curriculum. It also helped to break down the linkage between science and the English language, making science less foreign and exotic and more accessible. Introducing competition into classes was also seen to increase the range of knowledge sources that students drew on. Both of these practices are relatively simple ones that could easily be encouraged within teacher training.

A key aspect to the success of Miss Muna's teaching technique was that she set the class the problems as homework and also that each group was given a different question to research. Giving the task as homework meant that students had more time to explore a wider variety of sources. In the context of Dafina school, where Miss Muna taught, the range of sources available outside class was still limited as there were no libraries, but the students would have had access to a wider range of texts, both published and copied notes, in the school as a whole than in their class. Giving each group a different question meant that there was a requirement for the groups to teach the other groups and it gave the other groups the incentive to learn from the presenting group and to question them in order to ensure that they understood. It also overcame the problem of all students providing identical answers to their homework questions. Whilst answers may have been shared within each group, the task of formulating the answers was distributed across the groups rather than falling on one or two individuals which often appeared to be the case with whole class homework.

Miss Muna's lesson and the example of the peer teaching carried out by my ex-chemistry class (see section 5.2.5) all point to the great potential of co-operative student-student teaching within the Tanzanian context. The hidden textbook and the phenomenon of identical homework answers demonstrate that Tanzanian students are highly efficient and practised at distributing information between themselves and operating in a group. Students are motivated enough in their learning to spend time outside class sharing knowledge sources. This culture of sharing academic knowledge may have arisen in response to the scarcity of information sources. As was noted in chapter one, authors such as Nyerere and Jegede have pointed to the collectivism of African cultures, contrasting this with the individualism promoted by

Western schooling. As Western models of pedagogy move more towards collaboration (see chapter one) there is potential for greater synergy between the pedagogical ideas promoted by Western educators and the learning culture of Tanzanians. This synergy may help explain the rapid spread and adoption of the idea of *njia shirikishi*. As more young teachers like Miss Muna are exposed to these ideas through the diploma curriculum and start putting them into practice, co-operative teaching and learning methodologies could greatly improve the quality of education in Tanzania.

However, the case of the hidden textbook, along with Mr Mtewa's chemistry lesson in which most groups gave the wrong answers, demonstrate the dangers of promoting co-operative learning practices whilst access to information sources remains limited. The first danger is that it can reinforce the sacred nature of the text through its conservation by replication. The second is that it can lead to the propagation of misconceptions. If students' ability and motivation to work collaboratively is to be fully exploited the students need to have access to a range of knowledge sources that can be understood by learners who lack fluency in English. It is also vital that teachers are secure enough in their own subject knowledge to be able to identify and correct misconceptions generated through group work.

In terms of recommendations for Western importers of pedagogy, the case of TEP and the diffusion of ideas through teacher training and into practice illustrate some of the problems of introducing new teaching techniques without sufficient attention to the context. In this study, some of the techniques promoted, such as group work, were problematic in practice as they were more time consuming than teacher-centred methods, but the learning outcome was still a replication of the text. Participatory methodology also made the teaching-learning situation more vulnerable to the introduction and propagation of misconceptions. Western facilitators need to take into account the very different knowledge environment of Tanzanian classrooms when suggesting new pedagogical techniques. It should not be assumed that teachers have robust enough content knowledge to support learner-centred pedagogies. Techniques drawn from local practice, such as those mentioned above and described



in chapter six, may have greater potential for improving learning than techniques developed in the information rich environment of Western schools.

#### **7.4. Implications for further research**

In chapter two I argued that, since the research field of pedagogy within Tanzanian classrooms was relatively unexplored, I had deliberately kept the research questions very open. The methodological approach was one of charting the field rather than of testing specific theories. By maintaining a very open set of research questions, I was able to identify a number of pertinent issues as they emerged from the data. A more focused approach may have missed some of these features of the pedagogical culture, such as the reliance on copied notes, or the role of definitions within science education. However, a disadvantage of this progressive focussing approach is that the most pertinent issues only came into focus at a late stage in the research process, leaving little opportunity to investigate them in any depth. As a result, many of the findings and conclusions from this work remain speculative, and further research would be needed to verify them. A further disadvantage of taking a very open approach that focused on depth of data rather than breadth, is one of generalisation. The internal validity of the findings has been greatly strengthened by comparing what teachers did with what they said and what their students said. The casual observations made while wandering round schools or talking informally gave a further source of verification. However, gaining depth means sacrificing breadth, and further research would be necessary in order to establish the extent to which these findings could be generalised beyond the research site.

In chapter six, one of the aspiration-reality gaps described was the aspiration to teach practical based science, due to its association with modernity, and the reality of unequipped or under-equipped schools. I argued that setting high requirements for practical work reduced teachers' capacity and confidence in their ability to teach using practical at all. All of the science educators that I spoke to expressed a belief that practical work led to better science teaching, yet there was very limited research evidence for this. The treatment of practical science as a separate and additional part

of the syllabus rather than a means of generating learning experiences may mean that the belief that practical work improves the learning of science is an unsubstantiated one. Comparison of student performance in the theory and practical papers at O' level could be used to explore this. Simple comparison of the results in the practical and alternative to practical paper would show very little in itself as it would not enable the researcher to distinguish between differences in student ability and differences in the difficulty of the assessment. However, if the results in the theory paper were compared, and other school quality and socioeconomic effects controlled for (e.g. by controlling for performance in non-science subjects) then it could be ascertained whether or not practical work, of the type tested for in the practical examination, contributes to better understanding of science. If there was found to be no linkage, then it could save the country a great deal of investment in high tech laboratory equipment for schools.

The same could also be argued for English medium instruction: if research could show that student performance was as good (or better) in Kiswahili medium than in English medium, *when other socio-economic and school quality factors are controlled for*, it could save the country from the disadvantages of English medium instruction. Some research of this type has been carried out as part of a project on the Language of Instruction in Tanzania and South Africa (LOITASA) project (Mwinsheikhe 2003) although the scope of the experiment carried out was very limited, partly due to a refusal by the Minister of Education and Culture at that time to allow secondary education to take place in Kiswahili even at an experimental level (Brock-Utne 2005a). English medium instruction is assumed to be necessary for learning English and attaining modernity, but the cognitive costs of this policy, as outlined in chapter six, may inhibit the attainment of a scientifically literate society.

A third influence on pedagogy that might be investigated further is the access to information within the science teaching community. One possible outcome of SEDP is that the demand for teachers will reduce even further the average level of education, training and experience of the teacher cadre, and this may strengthen the pedagogical culture of replication of a sacred text. However, at the same time the

level of access to information sources in general is increasing. Under a Sida funded project, it is intended that all teacher training colleges will have access to the internet (Mungai 2005). It would be valuable to research whether this increased access to information sources has a detectable influence on the way that trainees and teachers treat scientific knowledge, and whether access to a wide range of scientific texts through the internet is sufficient to alter the common view of science as consisting of a set text of definitions and laws that need to be preserved in their verbatim form. Whilst language may continue to limit access to many web-based information sources; there is an increasing amount of Kiswahili content on the World Wide Web.<sup>84</sup> It would be interesting to see whether the increased level of access to information will challenge or interact with the sacred text of secondary school science.

In chapter one I explored some of the possible alternatives to learner-centred teaching paradigms that have been illustrated through East-West comparisons of pedagogical culture. Part of the motivation to carry out these comparative studies was the apparent success of many Asian countries in international achievement tests. The findings indicated that Western assumptions about 'good teaching' were ethnocentric and that alternative pedagogies were often more effective in terms of improving student performance. Given Africa's poor performance in these tests it is more difficult to justify the argument that African pedagogies are viable alternatives to the European/ American models. The low performance of African students can be used to justify Beeby's linear development model. This would support the continued import of Western pedagogical ideas although would call for the import to be adjusted to suit the stage of development which the education system has reached. However, it was also suggested that Eastern pedagogical culture might have greater congruence with African pedagogical culture than European models. African and Asian societies tend to be described as more focused on the community than on the individual. Memorisation is highly valued in African schools and Asian schools whereas in Europe it is often seen as an undesirable, shallow approach to learning. The question remains that, given these apparent similarities in pedagogical culture,

---

<sup>84</sup> See for example the Kiswahili Wikipedia at <http://sw.wikipedia.org/wiki/Mwanzo> (accessed 19/10/06).

how is it that African students tend to perform poorly on international tests in which Asian students perform so well? Comparative study of Asian and African pedagogical culture would bring some illumination to this paradox, and would act as a guard against the assumption that Western models of pedagogy are a universal ideal for all societies to aim for. The outcomes of Japanese facilitated science teacher training projects such as the Strengthening of Mathematics and Science in Secondary Education<sup>85</sup> (SMASSE) project in Kenya and Ghana could also provide new insights into this question.

Overall, this research highlights the way that global factors have influenced what takes place within Tanzanian science classrooms. It also demonstrates how the local approaches to teaching and learning have altered pedagogies introduced from outside. It points to the futility of trying to identify and preserve what is indigenous and 'locally relevant' whilst identifying problems with attempts to embrace a model of modernity based on images of the West. Nyerere's *Education for Self-Reliance* envisaged an education that would be relevant to the lives of poor, rural Tanzanians and that would take pride and benefit from local knowledge. It called for development to be based on the consideration of Tanzania's own resources rather than on the values of Western societies. However, in his call to accelerate the rate of development, to run while others walk, he revealed the problem of the philosophy of self-reliance: that a country's own development is inevitably referenced against the position of others. The metaphor implies a need to 'catch up' with other countries. The education development targets, both in policy and in the popular imagination, have been set with reference to an image of life in the West rather than the reality of life in Tanzania. This gap between aspiration and reality has shaped the way that teachers teach and students learn science.

---

<sup>85</sup> See <http://www.smasse.org> (accessed 13/11/06).

## Bibliography

- Adey, P. (1997). "It all depends on the context, doesn't it? Searching for general, educable dragons." Studies in Science Education **29**: pp.45-91.
- Adey, P. and Shayer, M. (1994). Really Raising Standards: cognitive intervention and academic achievement. London, Routledge.
- Agar, M. H. (1996). The Professional Stranger. 2nd ed. London, Academic Press.
- Aikenhead, G. S. and Jegede, O. J. (1999). "Cross-cultural science education: a cognitive explanation of a cultural phenomenon." Journal of Research in Science Teaching **36**(3): pp. 269-287.
- Akatugba, A. H. and Wallace, J. (1999). "Sociocultural influences on physics students' use of proportional reasoning in a non-Western country." Journal of Research in Science Teaching **36**(3): pp. 305-320.
- Alexander, R. J. (2000). Culture and Pedagogy: international comparisons in primary education. Oxford, Blackwell Publishers.
- Alexander, R. J. (2001). "Border crossings: towards a comparative pedagogy." Comparative Education **37**(4): pp. 507-523.
- Anangisyse, W. (2006). Educating teachers, the ethical dimension of teacher professionalism in Tanzania. Unpublished PhD thesis, Edinburgh, Moray House School of Education University of Edinburgh.
- Antioch New England Graduate School (2003). "Education by design." <http://www.edbydesign.org/> : downloaded 10/03/03.
- Archer, D. and Cottingham, S. (1996). The Reflect Mother Manual: a new approach to adult literacy. London, ActionAid.
- Arthur, J. (2001). "Perspectives on educational language policy and its implementation in African classrooms: a comparative study of Botswana and Tanzania." Compare **31**(3): pp. 347-362.
- Ball, S. J. (1983). "Imperialism, social control and the colonial curriculum in Africa." Journal of Curriculum Studies **15**(3): pp. 237-263.
- Barrett, A. (2005). Teacher identity in context: a comparison of Tanzanian with English primary school teachers. PhD thesis, Graduate School of Education, University of Bristol.
- Bechhofer, F. and Patterson, L. (2000). Principles of Research Design in the Social Sciences. London, Routledge.
- Beeby, C. (1966). Quality of Education in Developing Countries. Paris, Harvard University Press.
- Beidelman, T. O. (1965). "Notes on boys' initiation among the Ngulu of East Africa." Man **65** (Sept-Oct): pp. 143-147.
- Bekalo, S. and Welford, G. (2000). "Practical activity in Ethiopian secondary physical sciences: implications for policy and practice of the match between the intended and implemented curriculum." Research Papers in Education **15**(2): pp. 185-212.
- Bennell, P. and Segerstrom, J. (1998). "Vocational education and training in developing countries- has the World Bank got it right?" International Journal of Education in Development **18**(4): pp. 271-287.
- Bentley, D. and Watts, M. (Eds) (1989). Learning and Teaching in School Science: practical alternatives. Milton Keynes; Philadelphia, Open University Press.



- Bird, D. (1998). Never the Same Again: a history of VSO. London, VSO.
- Bloch, M. E. F. (1998). How We Think They Think: anthropological approaches to cognition, memory and literacy. Boulder, Westview Press.
- Bourdieu, P. (1971). Systems of education and systems of thought. In M. F. D. Young (Ed). Knowledge and Control: new directions for the sociology of education. London, Collier Macmillan.
- Brennan, B. (1990). "Indigenous learning revisited." Adult Education and Development 35 (Sept): pp. 73-88.
- Brock-Utne, B. (1995). "Cultural conditionality and aid to education in East Africa." International Review of Education 41(3-4): pp. 177-197.
- Brock-Utne, B. (1996). "Reliability and validity in qualitative research within education in Africa." International Review of Education 42(6): pp. 605-621.
- Brock-Utne, B. (2000). Whose Education for All? The recolonization of the African mind. New York: London, Falmer Press.
- Brock-Utne, B. (2004). "But English is the language of science and technology" The language of instruction in Tanzania. In G. Gudmundsdottir (Ed.) Disseminating and Using Research Results from the South. Report no.3.2003. Oslo, Institute for Educational Research: pp. 30-51.
- Brock-Utne, B. (2005a). The continued battle over KiSwahili as the language of instruction in Tanzania. In B. Brock-Utne and R. K. Hopson (Eds). Languages of Instruction for African Emancipation: focus on Postcolonial contexts and considerations. Cape Town: Dar es Salaam, Centre for Advanced Studies of African Society (CASAS); Mkuki na Nyota Pubs: pp. 51-88.
- Brock-Utne, B. (2005b). "Learning through a familiar language versus learning through a foreign language- a look into some secondary school classrooms in Tanzania." Learning and Livelihood, 8th UKFIET International Conference on Education and Development. Oxford, September 13-15, 2005.
- Brock-Utne, B. and Holmarsdottir, H. B. (2004). "Language policies and practices in Tanzania and South Africa: problems and challenges." International Journal of Educational Development 24(1): pp. 67-83.
- Brodie, K., Lelliott, A. and Davis, H (2002). "Forms and substance in learner-centred teaching: teachers' take-up from an in-service programme in South Africa" Teaching and Teacher Education 18(5): pp. 541-559.
- Brown, J. S., Collins, A and Duguid, P. (1989). "Situated cognition and the culture of learning." Educational Researcher 18(1): pp. 32-42.
- Bruner, J. S. (1996). The Culture of Education. Cambridge, Mass; London, Harvard University Press.
- Buchert, L. (1994). Education in the Development of Tanzania, 1919-90. London, James Currey.
- Butterworth, G. (1992). Context and cognition in models of cognitive growth. In P. Light and G. Butterworth (Eds). Context and Cognition: ways of learning and knowing. Hemel Hempstead, Harvester Wheatsheaf: pp1-13.
- Caddell, M. (2002). Outward Looking Eyes: visions of schooling, development and the state in Nepal. Unpublished PhD thesis, University of Edinburgh.
- Cadogan, T. E. (2005). Students and Schools in the Southern Highlands: education in Tanzania 1890s to the present. Unpublished PhD thesis. School of Oriental and African Studies. London, University of London.

- Calderhead, J. (1996). Teachers' beliefs and knowledge. In D. Berliner and R. Calfree (Eds) Handbook of Educational Psychology. New York, Macmillan: pp. 702-725.
- Cameron, J. and Dodd, W. A. (1970). Society, Schools and Progress in Tanzania. Oxford, Pergamon.
- Carr-Hill, R. (1984). Primary Education in Tanzania: a review of the research. Stockholm, Swedish International Development Authority, Education Division.
- Case, R. (1998). Changing views of knowledge and their impact on educational research and practice. In D. R. Olson and N. Torrance (Eds) The Handbook of Education and Human Development. Oxford, Blackwell.
- Chambers, R. (1984). Rural Development: putting the last first. London, Longman.
- Chambers, R. (1997). Whose Reality Counts? Putting the first last. London, Intermediate Technology Publications.
- Cheng, K.-M. (1994). Quality of education as perceived in Chinese culture. In T. Takala (Ed.) Quality of education in the context of culture in developing countries. Tampere, University of Tampere, Department of Education: pp. 67-84.
- Christie, P. and Collins, C. (1984). Bantu education: Apartheid ideology and labour reproduction. In P. Kallaway (Ed.). Apartheid and Education: the education of Black South Africans Johannesburg, Raven Press: pp. 160-184.
- Cole, M. (2005). "Cross-cultural and historical perspectives on the developmental consequences of education." Human Development 48(4): pp. 195-216.
- Collins, H. M. (2001). "Tacit knowledge, trust and the Q of sapphire." Social Studies of Science 31(1): pp. 71-85.
- Commission for Africa (2005) Our Common Interest: report of the Commission for Africa. London: DfID.
- Cooksey, B. (1986). "Policy and practice in Tanzania secondary education since 1967." International Journal of Educational Development 6(3): pp. 183-202.
- Cooksey, B., Levey, L. and Mkunde, D. (2001). The Partnership for Higher Education in Africa: Higher Education in Tanzania: A case study. New York, Carnegie Corporation.
- Dahlgren, L. O. (1984). Outcomes of learning. In F. Marton, D. Hounsell and N. Entwistle (Eds) The Experience of Learning. Edinburgh, Scottish Academic Press: pp. 19-35.
- Davidson, E. (2005). Understanding and Improving Quality in Tanzanian Primary Schooling. Unpublished PhD thesis, School of Development Studies, University of East Anglia,
- Department for International Development (1999). Tanzania: country strategy paper. London, DfID.
- Dewey, J. (1897). "My pedagogic creed." School Journal 54: pp. 77-80.
- Dewey, J. (1916/1966). Democracy and Education: an introduction to the philosophy of education. New York, Free Press, Collier-Macmillan.
- Dey, I. (1999). Grounding Grounded Theory: guidelines for qualitative inquiry. San Diego, London, Academic Press.
- Dickens, C. (1854/1955). Hard Times. London, Oxford University Press.
- Donaldson, M. (1978). Children's Minds. Glasgow, Fontana.

- Donn, G. (2005). The challenge of researching education in Commonwealth African countries. In D. Hammett and R. Wedgwood (Eds) The Methodological Challenges of Researching Education and Skills Development in Africa. Edinburgh, Centre of African Studies, University of Edinburgh: pp. 85-96.
- Dore, R. (1976). The Diploma Disease: education, qualification and development. London, Allen and Unwin,
- Driver, R. (1983). The Pupil as a Scientist? Milton Keynes, Open University Press.
- Driver, R. (1991). "Culture clash: children and science." New Scientist **130**(1775): pp. 46-48.
- Dyasi, H. M. (1976). The teaching-learning strategy of the Primary Science Project of the Science Education Programme for Africa. Seminar on Teaching - Learning Strategies and Educational Planning. Paris, March, 8-12, 1976, International Institute for Educational Planning: seminar paper 30.
- Dzama, E. N. N. and Osborne, J. F. (1999). "Poor performance in science among African students: An alternative explanation to the African worldview thesis." Journal of Research in Science Teaching **36**(3): pp. 387-405.
- Eliufoo, S. N. (1968). The aims and purposes of Tanzanian education since Independence. In I. N. Resnick Tanzania: revolution by education. Arusha, Longmans of Tanzania Ltd: pp. 33-48.
- Engida, T. (2002). "Reflections on African science education for the new millennium: the case of the Ethiopian chemistry curriculum for beginners." International Journal of Science Education **24**(9): pp. 941-953.
- Entwistle, N. (1984). Contrasting perspectives on learning. In F. Marton, N. Entwistle and D. Hounsell (Eds). The Experience of Learning. Edinburgh, Scottish Academic Press: pp. 1-18.
- Entwistle, N. Skinner, D., Entwistle, D. and Orr, S. (2000). "Conceptions and beliefs about "Good Teaching": an integration of contrasting research areas." Higher Education Research and Development **19**(1): pp. 5-26.
- Eraut, M. (1994). Developing Professional Knowledge and Competence. London/ New York, RoutledgeFalmer.
- Eshiwani, G. S. (1993). Education in Kenya Since Independence. Nairobi, East African Educational Publishers.
- Foster, P. J. (1965). The vocational school fallacy in development planning. In C. A. Anderson and M. J. Bowman (Eds). Education and Economic Development. Chicago, Aldine Publishing Co.: pp. 142-166.
- Foster, P. J. (1969). Education for Self-Reliance: a critical evaluation. In R. Jolly (Ed.) Education in Africa: research and action. Nairobi, East African Publishing House: pp. 81-101.
- Freire, P. (1972). Pedagogy of the Oppressed. Translated from the Portuguese by Myra Bergman Ramos. London, Penguin.
- Frommer, H. and Weingardt, M. (2003). Science Education in Secondary Schools project report: 2003 impact research. Dar es Salaam, GTZ.
- Fuller, B. (1991). Growing-up Modern: the Western state builds third-world schools. New York; London, Routledge.
- Fuller, B. and Clark, P. (1994). "Raising school effects while ignoring culture? Local conditions and the influence of classroom tools, rules and pedagogy." Review of Educational Research **64**(1): pp. 119-157.

- Gado, I. and Simonis, D. (2004). Linguistic difficulties in learning science concepts in a multilingual elementary school in Benin. In K. Mutua and C. S. Sunal (Eds). Education in Africa, The Caribbean and the Middle East: an historical overview. Greenwich, USA, Information Age Publishing: pp. 11-32.
- Glaser, B. G. and Strauss, A. L. (1967). The Discovery of Grounded Theory: strategies for qualitative research. Chicago, Aldine Pub. Co. New York.
- Glick, J. (1974). Culture and cognition: some theoretical and methodological concerns. In G. D. Spindler (Ed.) Education and the Cultural Process: towards an anthropology of education. New York, Holt, Reinhart and Winston Inc.: pp. 373-383.
- Government of Tanganyika (1947). Ten Year Plan for the Development of African Education. Dar es Salaam, Government Printers.
- Government of Tanganyika (1956). Five Year Plan for African Education 1957-1961. Dar es Salaam, Government Printers.
- Gray, B. V. (1999). "Science education in the developing world: issues and considerations." Journal of Research in Science Teaching **36**(3): pp. 261-268.
- Guardian (2004). Parents will sue over exams leakage. Dar es Salaam 09/11/2004. <http://www.ipp.co.tz/ipp/guardian/2004/11/09/24158.html> : downloaded 03/02/06.
- Guthrie, G. (1980). "Stages of educational development? Beeby revisited." International Review of Education **26**(4): pp. 488-438.
- Gwimbi, E. (2003). "A study of the association of attitudes to the philosophy of science with classroom contexts, academic qualifications and professional training amongst A' level Biology teachers in Harare, Zimbabwe." International Journal of Science Education **25**(4): pp. 469-488.
- Hammersley, M. (1990). Classroom Ethnography. Milton Keynes, Open University Press.
- Hammersley, M. and Atkinson, P. (1983). Ethnography: principles in practice. London:New York, Tavistock Pubs.
- Hammett, D. and Wedgwood, R. (Eds) (2005). The Methodological Challenges of Researching Education and Skills Development in Africa. Edinburgh, Centre of African Studies, University of Edinburgh.
- Heyneman (2003). "The history and problems in the making of education policy at the World Bank 1960–2000" International Journal of Educational Development **23**(3): pp. 315-337.
- Holtom, D. (2003). Coercion and Consent: the World Bank in Tanzania 1970-2001. Unpublished PhD thesis, Centre for Development Studies, University of Wales, Swansea.
- Hongoke, C. J. (1997). Educational Innovation in Developing Countries: the case for Unified Science in Tanzania. Unpublished PhD thesis. Manchester, University of Manchester.
- Hopkins, A. G. (1973). An Economic History of West Africa. London, Longman.
- Horton, R. (1967). "African traditional thought and Western science." Africa **37**: pp. 50-71: 155-187.
- Hyden, G. (1979). Policy making in Tanzania: we must run while others walk. In J. D. Barkan and J. J. Okumu (Eds). Politics and Public Policy in Kenya and Tanzania. New York, Praeger Publishers: pp. 96-103.



- Isaacs, A. (Ed.) (2000) A Dictionary of Physics, 4th Edition. Oxford; New York, Oxford University Press.
- Jansen, J. (2005a). Why recitation persists: the relationship between authority and pedagogy in third world classrooms. In M. Beveridge, K. King, R. Palmer and R. Wedgwood (Eds) Reintegrating Education, Skills and Work in Africa. Edinburgh, Centre of African Studies, University of Edinburgh: pp. 105-135.
- Jansen, J. (2005b). 'Lost in translation?' Researching education in Africa. In D. Hammett and R. Wedgwood (Eds) The Methodological Challenges of Researching Education and Skills Development in Africa. Edinburgh, Centre of African Studies, University of Edinburgh: pp. 16-25.
- Jegede, O. J. (1995). "Collateral learning and the eco-cultural paradigm in science and mathematics education in Africa." Studies in Science Education **25**: pp. 97-137.
- Jegede, O. J. (1999). Science education in nonwestern cultures: towards a theory of collateral learning. In L. Semali and J. L. Kincheloe (Eds). What is Indigenous Knowledge? Voices from the academy. New York and London, Falmer press: pp. 119-142.
- Jegede, O. J., Fraser, B. J. and Okebukloa, P.A. (1994). "Altering socio-cultural beliefs hindering the learning of science." Instructional Science **22**(2): pp. 137-152.
- Jenkins, E. W. (1979). From Armstrong to Nuffield: studies in twentieth-century science education in England and Wales. London, John Murray.
- Jennings, M. (2003). "'We must run while others walk': popular participation and development crisis in Tanzania, 1961-91." Journal of Modern African Studies **41**(2): pp. 163-187.
- Johnson, S., Monk, M. and Swain, J. (2000). "Constraints on development and change to science teachers' practice in Egyptian classrooms." Journal of Education for Teaching **26**(1): pp. 9-24.
- Jones, T.J. (1922) Education in Africa: a study of West, South and Equatorial Africa by the African Education Commission. New York , Phelps-Stokes Fund.
- Jones, T. J. (1925). Education in East Africa: a study of East, Central and South Africa. London, Edinburgh House Press.
- Kadeghe, M. (2003). In defence of continued use of English as the language of instruction in secondary and tertiary education in Tanzania. In B. Brock-Utne, Z. Desai and M. Qorro (Eds). Language of Instruction in Tanzania and South Africa (LOITASA). Dar es Salaam, E&D Ltd: pp. 170-186.
- Kamwela, T. (1977). "The historical development of secondary education in Tanzania and recommendations for the future." Papers in Education and Development **4**, Dept. of Education, University of Dar es Salaam: pp. 42-69.
- Kay, S. (1975). "Curriculum innovation and traditional culture: a case study of Kenya." Comparative Education **11**(3): pp. 183-191.
- Kenyatta, J. (1961). Facing Mount Kenya: the tribal life of the Gikuyu. London, Secker and Warburg.
- Kerr, S. (2006). The Tanzania Teachers Union: pay, performance and politics. Unpublished PhD thesis, Centre of African Studies, University of Edinburgh.
- Kesamang, M. E. E. and Taiwo, A.A. (2002). "The correlates of the socio-cultural background of Botswana junior secondary school students with their attitudes



- towards and achievements in science." International Journal of Science Education **24**(9): pp. 919-940.
- KfW (2002). Tanzania: community services of the Church- sector related programme, Education I. Frankfurt, KfW Entwicklungsbank
- Kibga, E. Y. K. (2003). The Role of Practical Assessment in the teaching and learning of Physics in O-Level Secondary Schools in Tanzania. Unpublished MEd (Sci) dissertation, University of Dar es Salaam.
- King, K. (1971). Pan-Africanism and Education: a study of race philanthropy and education in the Southern States of America and East Africa. Oxford, Clarendon Press.
- King, K. (1984). The End of Education for Self-Reliance in Tanzania? Edinburgh, Centre for African Studies.
- King, K. (1991). Aid and education in the developing world: the role of the donor agencies in educational analysis. Harlow, Longman.
- King, K. (2005). The challenges of the field and of field research, with particular reference to the informal sectors of Africa. In D. Hammett and R. Wedgwood (Eds). The Methodological Challenges of Researching Education and Skills Development in Africa. Edinburgh, Centre of African Studies, University of Edinburgh: pp.47-55.
- Kitosi, J. (2002). Reflections from the experience of the National Examinations Council of Tanzania (NECTA) in controlling examination irregularities. Association For Educational Assessment In Africa 20th annual conference: The Management And Administration Of Public Examinations Systems In Africa: Experiences On Examination Irregularities, Arusha, Tanzania, October 7-11, 2002,.
- Klitgaard, R. (1994). Taking culture into account: from "let's" to "how". In I. Serageldin and J. Tabaroff (Eds) Culture and Development in Africa: proceedings of an international conference held at the World Bank, Washington D.C. April 2 - 3, 1992. Washington D.C., World Bank: pp. 75-120.
- Knamiller, G. W., Ed. (1999). The Effectiveness of Teacher Resource Centre Strategy. DfID education papers 34. London, DfID.
- Knamiller, G. W., Osaki, K. M. and Kuonga, H. C. (1995). "Tanzanian teachers' understanding of the science embedded in traditional technologies: a study to inform teacher education." Research in Science and Technological Education **13**(1): pp. 67-76.
- Koosimile, A. T. (2002). "Access negotiation and curriculum change: lessons from Botswana." Qualitative Studies in Education **15**(2): pp. 205-223.
- Kuhn, T. S. (1970). The Structure of Scientific Revolutions. Chicago, University of Chicago Press.
- Kuleana (1999). The State of Education in Tanzania: crisis and opportunity. Mwanza, Kuleana.
- Kyle, W. C. (1999). "Science education in developing countries: challenging first world hegemony in a global context." Journal of Research in Science Teaching **36**, (3): pp. 255-260.
- Lassibille, G., Tan, J. P. and Sumra, S. (2001). "Expansion of private secondary education: lessons from recent experience in Tanzania." Comparative Education Review **44**(1): pp. 1-28.

- Lave, J. and Wenger, E. (1991). Situated Learning: legitimate peripheral participation. Cambridge, Cambridge University Press.
- Leshabari, M. T. and Masesa, Z. E. (2000). The impact of deteriorating quality of education in schools on the training of medical doctors in Tanzania. In C. J. Galabawa, F. E. M. K. Senkoro and A. F. Lwaitama (Eds). The Quality of Education in Tanzania. Dar es Salaam, University of Dar es Salaam, Faculty of Education: pp. 135-144.
- LeVine, R. A. and White, M. I. (1986). Human Conditions: the cultural basis of educational development. New York; London, Routledge and Kegan Paul.
- Lewin, K. and Dunne, M. (2000). "Policy and practice in assessment in Anglophone Africa: does globalisation explain convergence?" Assessment in Education: Principles, Policy & Practice 7(3): pp. 379-399.
- Lewis, L. J. (1948). Equipping Africa: educational development in British colonial Africa. London, Edinburgh House Press.
- Lewis, L. J. (1962). Education and Political Independence in Africa. Edinburgh, Thomas Nelson and Sons Ltd.
- Lillis, K. M. (1985). "School Mathematics of East Africa: a major system transfer." Compare 15(2): pp.141-159.
- Lillis, K. M. and Lowe, J. (1987). "The rise and fall of the Schools Science Project in East Africa." Compare 17(2): pp. 167-179.
- Lindhe, V., Malmberg, K. and Temu, E. (2005). Sida Support to Teacher Education in Tanzania 1997-2002. Stockholm, Swedish Development Cooperation Agency.
- Lubben, F., Campbell, B. and Dlamini, B. (1995). In-service support for a technological approach to science education. London, Overseas Development Agency.
- Lwaitama, A. F. and Rugemalira, J. M. (1990). The English Language Support Project in Tanzania. In C. M. Rubagumya (Eds). Language in education in Africa: a Tanzanian perspective. Clevedon, Multilingual Matters: pp. 36-41.
- Mafumiko, F. and Leliveld, M. (2006). Secondary Education In Africa (SEIA) Science, Mathematics and ICT (SMICT) study: Tanzania country profile. Africa Region Human Development Working Paper Series. Washington DC/ Amsterdam, Africa Region Human Development (AFTHD) The World Bank/ Vrije Universiteit Amsterdam.
- Mählck, L. and Temu, E. (1989). Distance versus college trained primary school teachers: a case study from Tanzania. Paris, UNESCO, International Institute for Educational Planning.
- Malawi Institute of Education (2004). Participatory Teaching and Learning: a guide to methods and techniques. Domasi, Malawi Institute of Education.
- Malekela, G. (2000). The quality of secondary education in Tanzania. In C. J. Galabawa, F. E. M. K. Senkoro and A. F. Lwaitama (Eds). The Quality of Education in Tanzania. Dar es Salaam, University of Dar es Salaam, Faculty of Education: pp. 61-76.
- Martin, E & Hine, R.S. (Eds) (2000). A Dictionary of Biology. 4th Edition. Oxford, Oxford University Press
- Marton, F. and Säljö, R. (1984). Approaches to Learning. In F. Marton, D. Hounsell and N. Entwisle (Eds). The Experience of Learning. Edinburgh, Scottish Academic Press: pp. 36-54.

- Mbembe, A. (2001). On the Postcolony. Berkeley; London, University of California Press.
- Mbilinyi, M. J. (1979a). History of formal schooling in Tanzania. In H. Hinzen and V. H. Hundsdorfer (Eds). Education for Liberation and Development: the Tanzanian experience. London, Evans Brothers Ltd: pp. 76-87.
- Mbilinyi, M. J. (1979b). Secondary education. In H. Hinzen and V. H. Hundsdorfer (Eds). Education for Liberation and Development: the Tanzanian experience. London, Evans Brothers Ltd: pp. 97-113.
- Mbiti, J. S. (1969). African Religions and Philosophy. London, Heinemann.
- McGuire, A., Nkunya, P. and Mihigo, J (1994). Enjoy Chemistry I. Morogoro, Mzumbe Book Project.
- Measor, L. (1985). Interviewing: a strategy in qualitative research. In R. G. Burgess (Ed.) Strategies of Educational Research: qualitative methods. London, Falmer Press: pp. 55-77.
- Merton, R. K. (1970). Science, technology & society in seventeenth century England [1st American ed.], New York, H. Fertig.
- Mhando, E. (2006). A note on the teacher status in Tanzania. First Meeting of National Coordinators for UNESCO's Teacher Training Initiative for sub-Saharan Africa. Dakar, Senegal, March 7-9, 2006, BREDA.
- Ministry of Education and Culture (1991). Basic Education Statistics in Tanzania (BEST), 1986-1990. Dar-es-Salaam, Ministry of Education and Culture.
- Ministry of Education and Culture (1995). Education and Training Policy. Dar es Salaam, Government Printers.
- Ministry of Education and Culture (1996a). Biology Syllabus for Secondary Schools form I-IV. Dar es Salaam, Tanzania Institute of Education.
- Ministry of Education and Culture (1996b). Chemistry Syllabus for Secondary Schools form I-IV. Dar Es Salaam, Tanzania Institute of Education.
- Ministry of Education and Culture (1996c). Physics Syllabus for Secondary Schools form I-IV. Dar Es Salaam, Tanzania Institute of Education.
- Ministry of Education and Culture (1996d). Syllabus for Teacher Education Diploma Level: Curriculum and Teaching. Dar es Salaam, Ministry of Culture and Education.
- Ministry of Education and Culture (2000a). Mwongozo wa utekelezaji wa mitaala mipya ya mafunzo ya ualimu Tanzania. (Guidelines for the implementation of the new curricula in teacher training in Tanzania.) Dar es Salaam, Ministry of Education and Culture.
- Ministry of Education and Culture (2000b). Syllabus for Teacher Education Diploma Level: Chemistry Teaching Methods. Dar es Salaam, Ministry of Culture and Education.
- Ministry of Education and Culture (2001). Education II Project: design of an in-service training system for secondary school science teachers. First interim report, Ministry of Education and Culture, Dar es Salaam.
- Ministry of Education and Culture (2003). Basic Statistics in Education 1999-2003. Dar es Salaam, Ministry of Education and Culture.
- Ministry of Education and Culture (2004a). Basic Statistics in Education 1995-2004. Dar es Salaam, Ministry of Education and Culture.

- Ministry of Education and Culture (2004b). Secondary Education Development Plan 2004-2009: final document. Dar es Salaam, Ministry of Education and Culture.
- Ministry of Education and Culture (2004c). Mafunzo ya Walimu Kazini: mwongozo wa kufundishia kwa kutumia njia/mbinu shirikishi. [In-service teacher training: guidelines to teaching using participatory ways/methods]. Dar es Salaam, Ministry of Culture and Education.
- Ministry of Education and Culture (2005a). Physics with Chemistry Provisional Syllabus for Form 1. Dar es Salaam, Tanzania Institute of Education.
- Ministry of Education and Culture (2005b). Provisional Biology Syllabus for Secondary Schools Form 1. Dar es Salaam, Tanzania Institute of Education.
- Ministry of Education and Culture and the University of Dar es Salaam (2005). In-service courses and materials for Science and Mathematics teacher trainers: college science tutors' training manual. Dar es Salaam, Ministry of Education and Culture.
- Mnganya, P. and Johnson, P. (2005). "“We must run while others walk” " Southern African News Features **46** (May 2005).  
<http://www.sardc.net/Editorial/Newsfeature/05460505.htm>: downloaded 11/12/06.
- Mosha, H. J. (1990). "Twenty years after education for self-reliance: a critical review." International Journal of Educational Development **10**(1): pp. 59-67.
- Mosha, H. J. (2000). Conceptualising quality of education. In C. J. Galabawa, F. E. M. K. Senkoro and A. F. Lwaitama (Eds). The Quality of Education in Tanzania. Dar es Salaam, University of Dar es Salaam, Faculty of Education: pp. 1-20.
- Mudimbe, V. Y. (1988). The Invention of Africa: gnosis, philosophy and the order of knowledge. Bloomington and Indianapolis, Indiana University press/ London, James Currey.
- Mukyanuzi, F. B. (1978). Implications of colonial examination systems in secondary schools in Tanzania. Papers in Education and Development **6**, Dept. of Education, University of Dar es Salaam: pp. 76-105.
- Mukyanuzi, F. (2003). Where has all the Education gone in Tanzania? Employment outcomes among secondary school and university leavers. Dar es Salaam, DfID.
- Mulhall, A. and Taylor, P. (1997). Contextualising Teaching and Learning in Rural Primary Schools: using agricultural experience. London, DfID.
- Mullis, I. V. S., Martin, M. O., Gonzalez, E.J. and Chrostowski, S.J. (2004). Findings from IEA's Trends in International Mathematics and Science Study at the Fourth and Eighth Grades. Chestnut Hill, MA, TIMSS & PIRLS International Study Center, Boston College.
- Mumford, B. W. (1930). "Malangali school." Africa **3**(3): pp. 265-292.
- Mungai, J. J. (2004). Hotuba ya Waziri wa Elimu na Utamaduni kuhusu makadirio ya matumizi ya fedha kwa mwaka 2004/2005 [Speech by the Minister for Education and Culture about the estimates for spending for the year 2004/05]. Dodoma, Tanzania, July 9, 2004.
- Mungai, J. J. (2005). Hotuba ya Waziri wa Elimu na Utamaduni kuhusu makadirio ya matumizi ya fedha kwa mwaka 2005/2006 [Speech by the Minister for



- Education and Culture about the estimates for spending for the year 2005/06]. Dodoma, Tanzania, July 5, 2005.
- Murray, A. V. (1938/1967). *The School in the Bush*. London, Frank Cass and co. Ltd.
- Musar, A. (1993). Equipment for Science Education: constraints and opportunities. ESP Discussion Paper Series, No 11. Washington D.C., World Bank.
- Mushi, P. A. K. (1989). "Deficiencies of indigenous African pedagogy." Adult Education and Development 32: pp. 87-94.
- Mushi, R., A. Penny, et al. (2003). Joint review of the Primary Education Development Plan. Dar es Salaam, United Republic of Tanzania, Ministry of Education and Culture.
- Mwinsheikhe, H. (2003). Using Kiswahili as a medium of instruction in science teaching in Tanzanian secondary schools. In B. Brock-Utne, Z. Desai and M. Qorro (Eds). Language of Instruction in Tanzania and South Africa. Dar es Salaam, E&D Limited: pp. 129-148.
- Mwinsheikhe, H. and Vuzo, M (2005). The medium of instruction in Tanzanian secondary schools: a hindrance to classroom interaction, learning and a sense of identity. Learning and Livelihood, 8th UKFIET International Conference on Education and Development. Oxford, September 13-15, 2005.
- Nagao, M. (2003). Could Japan be a good math and science teacher for Africa? The State of Education: Quantity, Quality and Outcomes, 7th UKFIET International Conference on Education and Development. Oxford, September 9-11, 2003.
- Narayan, D. (1997). Voices of the Poor: poverty and social capital in Tanzania. Washington D.C., World Bank.
- National Examination Council of Tanzania (2003). CSEE Examination formats. Dar es Salaam, NECTA.
- National Examination Council of Tanzania (2005). CSEE 2004 Preliminary Form V Allocations Dar es Salaam, NECTA.  
<http://www.necta.go.tz/form5/FORM5.htm>; downloaded 16/01/06.
- Ndabi, D. M. (2003). Assessment of students' achievement in Tanzania secondary schools. Sub-regional conference on assessment: learner assessment for improved educational quality: an exchange of current ideas and best practices. Livingstone, Zambia, June 30-July 2, 2003.
- Neke, S. M. (2002). English in Tanzania: an anatomy of hegemony. Unpublished PhD thesis. Afrikaanse Talen en Culturen. Ghent, Universiteit Gent (Ghent University).
- Nkunya, M. H. H. (2001). The state and mastery of science and technology in the Tanzanian education system. In A. F. Lwaitama, E. P. Mtalo and L. Mboma (Eds). The Multi-dimensional Crisis of Education in Tanzania: debate and action. Dar es Salaam, University of Dar es Salaam Convocation: pp. 196-205.
- Nuffield Foundation (1966). Nuffield Chemistry Introduction and Guide. London, Nuffield Foundation Science Teaching Project: Longmans.
- Nuffield Foundation and The Colonial Office (1953). African Education: a study of educational policy and practice in British Tropical Africa. Oxford, University Press.
- Nunes, T. and Bryant, P. (1996). Children Doing Mathematics. Oxford, Blackwell.



- Nyerere, J., K (1967). Education for Self-Reliance, Arusha, United Republic of Tanzania.
- O'Sullivan, M. (2004). "The reconceptualisation of learner-centred approaches: a Namibian case study." International Journal of Educational Development 24(6): pp. 585-602.
- Ocitti, J. P. (1994). "An Introduction to Indigenous Education in East Africa." Supplement to Adult Education and Development 42: pp. 1-126.
- Ogunbunmi, S. and Oliatan, H. M. (1998). Elements of Physics in Yoruba culture. In E. C. Eze. (Ed.). African Philosophy: an anthology. Malden, Mass., Blackwell Publishers, pp. 163-170.
- Ogunniyi, M. B., Jegede, O. J. et al. (1995). "Nature of worldview presuppositions among science teachers in Botswana, Indonesia, Japan, Nigeria, and the Philippines." Journal of Research in Science Teaching 32(8): pp. 817-831.
- Olson, D. R. (1991). Literacy and objectivity: the rise of modern science. In D. R. Olson and N. Torrance (Eds). Literacy and Orality. Cambridge, Cambridge University Press: pp. 149-164.
- Olson, D. R. (1996). Literate mentalities: literacy, consciousness of language, and modes of thought. In D. R. Olson and N. Torrance (Eds). Modes of Thought: explorations in culture and cognition. Cambridge, Cambridge University Press: pp.141-151.
- Olson, D. R. and Bruner, J. S. (1998). Folk psychology and folk pedagogy. In D. R. Olson and N. Torrance (Eds). The Handbook of Education and Human Development. Oxford, Blackwell: pp. 9-27.
- Omari, I. M. (1994). Review of critical issues in Tanzanian education. Investing in Human Capital Workshop, Ausha, April 1994. World Bank, Dar es Salaam
- Ong, W. J. (1982/2002). Orality and Literacy: the technologizing of the word, 2<sup>nd</sup> edition. London and New York, Routledge.
- Osaki, K. M. (2000). Curriculum and quality. In C. J. Galabawa, F. E. M. K. Senkoro and A. F. Lwaitama (Eds). The Quality of Education in Tanzania. Dar es Salaam, University of Dar es Salaam, Faculty of Education: pp. 225- 250.
- Osaki, K. M. (2004). Tanzania: reflections on the secondary education analysis and development programme. 2nd Secondary Education in Africa Conference, Dakar, Senegal June 6-9, 2004.
- Osaki, K. M. and Njabili, A. F. (2003). Secondary Education Sector Analysis. Dar es Salaam, The United Republic of Tanzania, Ministry of Education and Culture.
- Osaki, K. M. and Samiroden, W. D. (1990). "Children's conceptions of "living" and "dead."" Journal of Biological Education 24(3): pp. 199-207.
- Parlett, M. R. and Hamilton, D. (1973). Evaluation as Illumination: a new approach to the study of innovatory programs. Occasional paper 9. Edinburgh, University of Edinburgh, Centre for Research in the Educational Sciences.
- Perkins, D. N. (1999). "The many faces of constructivism." Educational Leadership 57(3): pp. 6-11.
- Perkins, D. N. and Grotzer, T. A. (1997). "Teaching intelligence." American Psychologist 52(10): pp. 1125-33.
- Piaget, J. (1978). The Development of thought: equilibration and cognitive structures. Translated by Arnold Rosin. Translation of: 'L'équilibration des

- structures cognitives'. Paris : Presses Universitaires de France, 1975. Oxford, Basil Blackwell.
- Polanyi, M. (1967). The Tacit Dimension. London, Rouledge & Kegan Paul Ltd.
- Polkinghorne, J. C. (1998). Belief in God in an age of science. New Haven; London, Yale University Press.
- Pratt, S. (1969). Secondary Level Teachers: supply and demand in Tanzania. Michigan, Michigan State University.
- Prophet, R. (1988). Science, language and culture. In G. D. Thijs, H. H. Boer, I. G. Macfarlane and G. J. Stoll (Eds). Learning Difficulties and Teaching strategies in Secondary School Science and Mathematics. Amsterdam, CDCS, Free University Press: pp.131-138.
- Prophet, R. (1995). "Views from the Botswana junior secondary classroom: case study of a curriculum intervention." International Journal of Educational Development **15**(2): pp. 127-140.
- Prophet, R. and Rowell, P. M. (1993). "Coping and control: science teaching strategies in Botswana." International Journal of Qualitative Studies in Education **6**(3): pp.197-209.
- Prophet, R. and Vlaardingerbroek, B. (2003). "The relevance of secondary school chemistry education in Botswana: a cognitive development status perspective." International Journal of Educational Development **23**(3): pp. 275-289.
- Pryor, J. and Ampiah, J. G. (2003). Understandings of Education in an African Village: the impact of Information and Communication Technologies (Report on DfID Research Project Ed2000-88). London, DfID.
- Psacharopoulos, G. and Loxley, W. (1985). Diversified Secondary Education and Development. London, OUP.
- Qorro, M. (2003). Unlocking the language forts: the language of instruction in post primary education in Africa with special reference to Tanzania. In B. Brock-Utne, Z. Desai and M. Qorro (Eds). Language of Instruction in Tanzania and South Africa. Dar es Salaam, E&D Limited: pp. 187-196.
- Rajabu, A. R. (2000). Teachers' education in Tanzania. In C. J. Galabawa, F. E. M. K. Senkoro and A. F. Lwaitama (Eds). The Quality of Education in Tanzania. Dar es Salaam, University of Dar es Salaam, Faculty of Education: pp. 251-265.
- Rajani, R. (2001). Situational Analysis of Children in Tanzania. Dar es Salaam, UNICEF.
- Ravetz, J. (1971). Scientific Knowledge and its Social Problems. Oxford, Oxford University Press.
- Renes, P. B. (1970). Teacher training at Butimba: a case-study in Tanzania. Groningen, Wolters-Noordhoff Publishing.
- Reynolds, D. (1999). Creating a new methodology for comparative educational research: the contribution of the international school effectiveness research project. In R. J. Alexander, P. Broadfoot and D. Philips (Eds). Contexts, classrooms and outcomes: new directions in comparative educational research. (Volume 1), Wallingford, Symposium Books: pp. 135-148.
- Rodney, W. (1972). How Europe Underdeveloped Africa. Dar es Salaam, Tanzania Publishing House.

- Rogan, J. M. and Grayson, D. J. (2003). "Towards a theory of curriculum implementation with particular reference to science education in developing countries." International Journal of Science Education **25**(10): pp. 1171 - 1204.
- Rogan, J. M. and Macdonald, M. A. (1985). "The in-service teacher education component of an innovation: a case study in an African setting." Journal of Curriculum Studies **17**(1): pp. 63-85.
- Rousseau, J. J. (1762/1974). Émile. Translated from the French by Barbara Foxley, London, Dent & sons Ltd.
- Rowell, P. M. (1995). "Perspectives on pedagogy in teacher education: the case of Namibia." International Journal of Educational Development **15**(1): pp. 3-13.
- Rowell, P. M. and Prophet, R. (1990). "Curriculum-in-action: the 'practical' dimension in Botswana classrooms." International Journal of Educational Development **10**(1): p.p 17-26.
- Roy-Campbell, Z. M. (2001). Empowerment Through Language: the African experience in Tanzania and beyond. Trenton (NJ)/Asmara, Africa World Press.
- Roy-Campbell, Z. M. and Qorro, M. (1997). Language Crisis in Tanzania: the myth of English versus education. Dar es Salaam, Mkuki na Nyota Pubs.
- Rubagumya, C. M. (1991). "Language promotion for educational purposes: the example of Tanzania." International Review of Education **37**(1): pp. 67-85.
- Rubagumya, C. M. (2003). English medium primary schools in Tanzania: a new "linguistic market" in education? In B. Brock-Utne, Z. Desai and M. Qorro (Eds). Language of Instruction in Tanzania and South Africa. Dar es Salaam, E&D Limited: pp. 149-169.
- Rugemalira, J. M., Rubagumya, C. M. et al. (1990). Reflections on recent developments in language policy in Tanzania. In C. M. Rubagumya (Ed.). Language in Education in Africa: a Tanzanian perspective. Clevedon, Multilingual Matters: pp. 25-35.
- Ryan, G. W. and Bernard, H. R. (2003). Data management and analysis methods. In N. Denzin and Y. Lincoln (Eds). Collecting and Interpreting Qualitative Materials. Thousand Oaks; CA, Sage Publications: pp. 259-309.
- Sadler, M. (1900/1979). How far can we learn anything of practical value from the study of foreign systems of education? Address given to Guildford Education Conference, 20th Oct 1900. In J. H. Higginson (Ed.). Selections from Michael Sadler. Liverpool, DeJall & Meyorre International Pubs Ltd.: pp. 48-51
- Sambo, W. (2001). "The role of private tuition in secondary education in Tanzania." Papers in Education and Development **21**, Dept. of Education, University of Dar es Salaam: pp. 96-110.
- Samoff, J. (1991). "The facade of precision in education data sets and statistics: a troubling example from Tanzania." The Journal of Modern African Studies **29**(4): pp. 669-689.
- Samoff, J. and Carrol, B. (2003). From Manpower Planning to the Knowledge Era: World Bank policies on higher education in Africa. Paris, UNESCO Forum on Higher Education and Knowledge.
- Savage, M. (1998). Curriculum innovations and their impact on the teaching of science and technology. In M. Savage and P. Naidoo (Eds). African Science

- and Technology Education into the New Millennium: practice, policy and priorities. Kenwyn, S.A., Juta & Co. Ltd.: pp. 35-60.
- Saxe, G. B. (1988). "Candy selling and math learning." Educational Researcher 17(6): pp.14-21.
- Scanlon, D. G., Ed. (1964). Traditions of African Education. New York, Teachers College, Columbia University.
- Schlunk, M. (1914/1964). *Das Schulwesen in den deutschen Schutzgebieten* [public education in the German Protected Areas]. Translated from the German and abridged by Wallace Morgan. In D. G. Scanlon (Ed.). Traditions of African Education. New York, Teachers College Columbia University: pp. 27-50.
- Schwab, G. (1947). Tribes of the Liberian Hinterland: report of the Peabody Museum Expedition to Liberia. Edited with additional material by G.W. Harley. Cambridge, Mass., Peabody Museum of American Archaeology and Ethnography.
- Scott, J. C. (1990). Domination and the Arts of Resistance: hidden transcripts. London, Yale University Press.
- Scribner, S. and Cole, M. (1981). The Psychology of Literacy. Cambridge, Mass., Harvard University Press.
- Semali, L. (1999). "Community as classroom: dilemmas of valuing African indigenous literacy in education." International Review of Education 45(3/4): pp. 305-319.
- Semali, L. and Kincheloe, J. L. (1999). What is indigenous knowledge and why should we study it? In L. Semali and J. L. Kincheloe (Eds). What is Indigenous Knowledge? Voices from the Academy. New York and London, Falmer Press: pp. 3-58.
- Senkoro, F. E. M. K. (2004). The role of language in education and poverty alleviation: tool for access and empowerment. In C. J. Galabawa and A. Narman (Eds). Education, Poverty and Inequality. Dar es Salaam, KAD associates: pp. 46-58.
- Serpell, R. (1993). The Significance of Schooling: life-journeys in an African society. Cambridge, Cambridge University Press.
- Serpell, R. (2005). "Optimizing the developmental consequences of education: reflections on issues raised by Michael Cole." Human Development 48(4): pp. 217-222.
- Sharan, S., Ed. (1994). Handbook of cooperative learning methods. The Greenwood educators' reference collection. Westport, Conn.; London, Praeger.
- Shayer, M. (2002). Not just Piaget, not just Vygotsky, and certainly not Vygotsky as alternative to Piaget. In M. Shayer and P. Adey (Eds). Learning Intelligence: cognitive acceleration across the curriculum from 5 to 15 years. Buckingham; Philadelphia, Open University Press: pp. 179-195.
- Shayer, M. and Adey, P. (1981). Towards a Science of Science Teaching: cognitive development and curriculum demand. London, Heinemann Educational.
- Shayo, S. (2003). Effectiveness of Demonstration Secondary Schools in education and training of science teachers in Tanzania. Unpublished MEd(Sci) Dissertation, University of Dar es Salaam.
- Shumba, O. (1996). "Science teachers' assessment of the interaction of indigenous African culture with science education in Zimbabwe." Zimbabwe Journal of Educational Research 7(3): pp. 259-300.



- Shumba, O. (1999). "Relationship between secondary science teachers' orientation to traditional culture and beliefs concerning science instructional ideology." Journal of Research in Science Teaching **36**(3): pp. 333-355.
- Silverman, D. (1993). Interpreting Qualitative Data: methods for analysing talk, text and interaction. London, Sage.
- Skorov, G. (1966). Integration of educational and economic planning in Tanzania. African research monographs no. 6. Paris, IIEP.
- Slater, B. D. (2002). The ownership of knowledge: literacy and orality in theological education in Uganda. Unpublished PhD thesis, University of Edinburgh.
- Smith, L. T. (1999). Decolonizing methodologies: research and indigenous peoples. New York; London, Zed Books.
- Smith, W. E. (1973). Nyerere of Tanzania. London, Victor Gollancz. [previously published as: *We Must Run While They Walk: a portrait of Africa's Julius Nyerere*. New York, Random House.]
- Spencer, S. (2002). Indigenous technology as a basis for science education at the junior secondary school level: a Sierra Leonean case study. In M. Savage and P. Naidoo (Eds). Popularisation of Science and Technology Education: some case studies from Africa. London, Commonwealth Secretariat: pp. 213-227.
- Stambach, A. (2000). Lessons from Mount Kilimanjaro: schooling, community, and gender in East Africa. New York; London, Routledge.
- Stephens, D. (1990). An outsider in Kano. In G. Vulliamy, K. Lewin, and D. Stephens (Eds). Doing Educational Research in Developing Countries: qualitative strategies. London, The Falmer Press: pp.68-82
- Stephens, D. (2005). Culture in educational research in Africa: from the methodological to the practical. In D. Hammett and R. Wedgwood (Eds). The Methodological Challenges of Researching Education and Skills Development in Africa. Edinburgh, Centre of African Studies: pp. 26-46.
- Stigler, J. and Hiebert, J. (1999). The teaching gap: best ideas from the world's teachers for improving education in the classroom New York, Free Press.
- Stoffels, N. T. (2005). "'Sir, on what page is the answer?'" Exploring teacher decision-making during complex curriculum change, with specific reference to the use of learner support material." International Journal of Educational Development **25**(5): pp. 531-54.
- Strauss, S. and Shilony, T. (1994). Teachers' models of children's minds and learning. In L. A. Hirschfield and S. A. Gelman (Eds). Mapping the Mind: domain specificity in cognition and culture. New York, Cambridge University Press: pp. 455-473.
- Sugrue, C. (1997). "Student teachers' lay theories and teaching identities: their implications for professional development." European Journal of Teacher Education **20**(3): pp. 213-225.
- Sumra, S. (2006). The Living and Working Conditions of Teachers in Tanzania. Dar es Salaam, HakiElimu.
- Svard, A. (1998). "On two metaphors for learning and the dangers of choosing just one." Educational Researcher **27**(2): pp. 4-13.
- Tabulawa, R. (1997). "Pedagogical classroom practice and the social context: the case of Botswana." International Journal of Educational Development **17**(2): pp. 189-204.



- Tabulawa, R. (1998). "Teachers' perspectives on classroom practice in Botswana: implications for pedagogical change." International Journal of Qualitative Studies in Education **11**(2): pp. 249-268.
- Tabulawa, R. (2003). "International aid agencies, learner-centred pedagogy and political democratisation: a critique." Comparative Education **39**(1): pp. 7-26.
- Tanzania Institute of Education (1995). Secondary School Chemistry book 2. Dar es Salaam, Tanzania Institute of Education.
- Tanzania Institute of Education (1999). Module for Curriculum and Teaching: diploma in education. Dar es Salaam, Tanzania Institute of Education.
- Thijs, G. D., Dekkers, P. J. J. M. and Smith, U.L. (1993). Research into the understanding of the concept of force carried out in developing countries in co-operation with research in the Netherlands. Science Education in Developing Countries: from theory to practice, Jerusalem, January 3-8, 1993. Free University, Amsterdam: paper 1.
- Thompson, A. R. (1968). Ideas underlying British colonial education policy in Tanganyika. In I. N. Resnick (Ed). Tanzania: revolution by education. Arusha, Longmans of Tanzania Ltd: pp. 15-32.
- Thompson, A. R. (1976). Historical survey of the role of the churches in education from pre-colonial days to post-independence. In A. J. Gottneid (Ed.). Churches and Education in Tanzania. Nairobi, East African Publishing House: pp. 3-130.
- Tikly, L. (2001). Post-colonialism and comparative education research. In K. Watson (Ed.). Doing Comparative Education Research: issues and problems. Wallingford, Symposium Books: pp. 245-264.
- Tobin, J. (1999). Method and meaning in comparative classroom ethnography. In R. J. Alexander, P. Broadfoot and D. Philips (Eds). Contexts, classrooms and outcomes: new directions in comparative educational research. Volume 1. Wallingford, Symposium Books: pp. 113-134.
- Towse, P., Kant, D., Osaki, F and Kirua, N. (2002). "Non-Graduate teacher recruitment and retention: some factors affecting teacher effectiveness in Tanzania." Teaching and Teacher Education **18**(6): pp. 637-652.
- Trappes-Lomax, H. R. (1990). Can a foreign language be a national medium? In C. M. Rubagumya (Ed.). Language in education in Africa: a Tanzanian perspective. Clevedon, Multilingual Matters: pp. 94-104.
- UNESCO (1973). New UNESCO Source Book for Science Teaching. Paris, UNESCO.
- UNESCO (2004). Education For All Global Monitoring Report 2005: the quality imperative. Paris, UNESCO.
- UNICEF Bangladesh (1993). Visualisation in Participatory Programmes: a manual for facilitators and trainers involved in participatory group events. Dhaka, Bangladesh, Programme Communication and Information Section, UNICEF Bangladesh.
- United Republic of Tanzania (1984). Educational system in Tanzania towards the year 2000: recommendations of the 1982 Presidential Commission on Education (Makwetta Report). Dar es Salaam, Ministry of Education.
- United Republic of Tanzania (1998). National Poverty Eradication Strategy. Dar es Salaam.

- United Republic of Tanzania (1999). Development Vision 2025. Dar es Salaam, United Republic of Tanzania, <http://www.tanzania.go.tz/vision.htm>: downloaded 15.04.04.
- United Republic of Tanzania (2000). Poverty Reduction Strategy Paper. Dar es Salaam, United Republic of Tanzania (October 2000).
- United Republic of Tanzania (2001). Education Sector Development Programme Document: final draft. Dar es Salaam, United Republic of Tanzania.
- United Republic of Tanzania, Ministry of Finance. (2003). Budget Execution Report: budget for fiscal year 2002/2003. Dar es Salaam, Ministry of Finance.
- University of York Science Education Group (2003). "Salters GCSE science." <http://www.york.ac.uk/org/seg/gcsescience/pages/>: downloaded 15/04/03.
- Van Driel, J. H., Beijgaard, D. and Verloop, N. (2001). "Professional development and reform in science education: the role of teachers' practical knowledge." *Journal of Research in Science Teaching* **38**(2): pp. 137-158.
- Van Praagh, G. (1988). *Seeing it Through: travels of a science teacher*. Crawley, Frogna Publishers.
- Varkevisser, C. M. (1969). Growing up in Sukumaland. In: Centre for the Study of Education in Changing Societies (CESO) *Primary Education in Sukumaland (Tanzania)*. The Hague, Wolters-Noordhoff: pp. 42- 82.
- Vavrus, F. K. (2003). *Desire and Decline: schooling amid crisis in Tanzania*. New York; Oxford, Peter Lang.
- Verran, H. (2001). *Science and an African Logic*. Chicago; London, University of Chicago Press.
- Verspoor, A. M. and Leno, J. L. (1986). *Improving Teaching: a key to successful educational change*. Washington D.C., World Bank.
- Vygotsky, L. S. (1934/1962). *Thought and Language*. Edited and translated from the Russian by Eugenia Hanfmann and Gertrude Vakar. Massachusetts, MIT.
- Ware, S. (1992). *Secondary School Science in Developing Countries: status and issues*. Washington D.C. World Bank/IRDB.
- Waring, M. (1979). *Social Pressure and Curriculum Innovation: a study of the Nuffield Foundation Science Teaching Project*. London, Methuen.
- Wedgwood, R. (2003a). *The Export of Pedagogy from Britain to Tanzania 1950-1970 with special reference to Secondary Science Education*. Unpublished MSc dissertation, Edinburgh, Moray House School of Education, University of Edinburgh.
- Wedgwood, R. (2003b). Some Student Teachers' Perceptions of How Pupils Learn Abstract Science Concepts. Micro research project conducted as part of the fulfilment of MSc in Education by Research. Moray House School of Education. University of Edinburgh.
- Wedgwood, R. (2005). *Post-Basic Education and Poverty in Tanzania* (Post-Basic Education and Training Working Paper Series -no.1). Edinburgh, Centre of African Studies, University of Edinburgh.
- Wedgwood, R. and Hammett, D. (2005). The loneliness of the long distance researcher: methodological challenges of doctoral research on education and training in Africa. In D. Hammett and R. Wedgwood (Eds). *The Methodological Challenges of Researching Education and Skills*

- Development in Africa. Edinburgh, Centre of African Studies, University of Edinburgh: pp. 4-14.
- Wiredu, K. (1998). How not to compare African traditional thought and Western science. In E. C. Eze (Ed.) African Philosophy: an anthology. Oxford/Massachusetts, Blackwell Publishers: pp. 193-200.
- Wood, D. (2000). How Children Think and Learn, 2nd Edition. Oxford, Blackwell.
- Woods, P. (1985). Ethnography and theory construction in educational research. In R. G. Burgess (Ed.). Field Methods in the Study of Education. London; Philadelphia, Falmer Press: pp. 51-78.
- Woods, P. (1996). Researching the art of teaching: ethnography for educational use. London, Routledge.
- World Bank (1999a). Education Sector Strategy. Washington D.C., IBRD/ World Bank.
- World Bank (1999b). Tanzania - Social Sector Review. Washington D.C., World Bank.
- World Bank (2002) Constructing Knowledge Societies: new challenges for tertiary education. Washington: World Bank.
- World Bank (2004). Programme Document for a proposed financing to the United Republic of Tanzania for a Secondary Education Development Program. Washington DC, World Bank, Report No 27613.
- World Bank (2005) Expanding Opportunities and Building Competencies for Young People: a new agenda for secondary education. Washington: World Bank.
- World Conference on Education for All (1990). World declaration of Education for All and framework for action to meet basic learning needs. World Conference on Education for All, Jomtien, Thailand, March 5-9, 1990.
- World Education Forum (2000). The Dakar framework for action. Education for All: meeting our collective commitments, Dakar, Senegal, April, 26-28, 2000, UNESCO.
- Wundt, W. M. (1916). Elements of Folk Psychology: outlines of a psychological history of the development of mankind. Translated from the German by E.L. Schaub. London, G. Allen & Unwin Ltd.



## Appendix 1: Fieldwork timeline

July 04 - August 04	2 weeks formal language training followed by 6 weeks informal language training through self study and conversation practice in Kondo (former place of work in Tanzania)
Sept 04- mid October 04	Arranging research permit and visa in Dar es Salaam, Literature study at UDSM Further language study
13 <sup>th</sup> - 27 <sup>th</sup> Oct 04	2 weeks research visit to Zebaki TTC
Nov 04/ Dec 04	Return to the UK
Jan 05	Return to Zebaki Visit local education authorities Contact schools
24-28 <sup>th</sup> Jan 05	School visit to Alizeti SS
31 <sup>st</sup> Jan -8 <sup>th</sup> Feb 05	Visits to Batobato SS
28 <sup>th</sup> Feb- 4 <sup>th</sup> March 05	School visit to Dafina SS
7 <sup>th</sup> - 11 <sup>th</sup> March 05	School visit to Edeni SS
11 <sup>th</sup> -15 <sup>th</sup> April 05	School visit to Chambuzi SS
May 05	Return home for conference and supervision
June 05	Visits to TIE and MoEC
July 05	Visits to Morogoro TTC (TEP) and NECTA
25 <sup>th</sup> -27 <sup>th</sup> July	School visit to Fadhili SS
August/ Sept 05	Feedback visits to schools





## Appendix 2: List of Policy Makers Interviewed

Institution	Informant	Position	Date of Interview
MoEC	Sarah Kironde	Co-ordinator for diploma level, dept for teacher training	22/6/05
MoEC	Rose Massenga	Director, dept for teacher training	21/6/05
MoEC	Naomi Swai	Co-ordinator for inservice training, dept for teacher training	27/6/05
MoEC	Mathias Kanyelege	Education Officer in charge of Education II	6/6/5
MoEC	Richard Chediell	Co-ordinator for pre-service training and primary upgrading, dept for teacher training	21/6/05
MoEC	Elias Kibga	Education officer/ Co-ordinator for secondary Science (maths/physics)	4/10/04
TIE	Stephen Mwinuka	Head of Research Information and Training	7/6/05
TIE	John Massawe	Curriculum Developer for Secondary Science and Diploma course materials	27/6/05
Morogoro TTC	Enea Mhando	TEP Facilitator	11/7/05
Morogoro TTC	Lydia Kimaryo	TEP Facilitator	11/7/05
Morogoro TTC	Waldrine Maro	Science Tutor/ Education II materials developer.	11/7/05
NECTA	Janet Kitosi	CSEE science coordinator	24/6/05
NECTA	Grace Bulanga Agnes Hisa Ngassani Mageese	Biology coordinator Chemistry coordinator Physics coordinator	9/8/05 (group interview)
Regional Government office	- (see below)	Regional Education Officer	19/5/05
SESS regional office	-	Regional Technical Officer, SESS Project	4/2/05

(NB the names of regional officers have been omitted as identification of the region could compromise the anonymity of the schools)



## **Appendix 3: Example transcripts of lesson observation and follow-up interview, with coding**

### **Codes**

DFN= definition- either asked for by teacher or provided by student.

LAW= recital of a law

DEMO= demonstration (even just showing a maize leaf)

MISCO= misconception by teacher

GROUP= group work

RECAP= oral recap of the previous lesson at the start of the lesson

APP= application of scientific principle to everyday life

MISAPP= misapplication

LANG= language-poor use of English or use of Kiswahili

EXCUSE= externalising the locus of blame for poor learning

WRITTEN= sets written exercise

### **Lesson observation 28/7/05 Mr Chuma**

Fadhili SS

Physics form IVA 11.00 am

28 students

[T= teacher, B= boy, G= girl, C= class, boxed text shows the notes given on the blackboard]

T enters class and writes PHYSICS, the date is already on the left hand corner

T: there was a page you didn't write, just leave a page and then we go on.

[there are quite a few Abbott's around]

T: last time we talked about eddy currents, what did we say, what did we say?

B:[reads definition of eddy current from his notes] DFN RECAP

T: last lesson we talked about Faraday's iron ring [sketches on board and gives a brief summary] that sends us to the transformer. Have you ever heard this word 'transformer'?

C: yes

T: Who can define?

B: It is a source of electricity.

B: It is a device used to step up or step down a current and ...[inaudible] DFN

T: we have two types of transformer, one is a step up transformer and one is step down.  
[holds up a transformer] what is this from? APP DEMO

C: Radio

T: What type is there in a radio, what type is it?

B: Step down

T: How do you know?

B: Because the radio is only using a small current

T: yes- you know that a radio is just using maybe 4 cells which is 6 volts, how many volts are there from the a.c.?

C: 240 v

T: wires are carrying electricity a long way and there is some resistance to some voltages are lost on the way so there must be a step up to raise the level of the voltage. MISCO86

T: [writes from his notes ]

### TRANSFORMER

defn. DFN

a transformer is a device used to increase the size of emf or to reduce the emf

Types of transformer:

- step up transformer
- step down transformer

A step up transformer is the one that increases the size of emf. It has more turns in the secondary coil than in the primary coil. Step down transformer is the one that reduces the size of the emf. it has few turns in the secondary coil than in the primary coil.

[T holds up a manila sheet with a drawing of a step down and a step up transformer.

Points to the first one...]

T: is this a step up or step down?

C: step down

T: how can you tell?

B: the number of turns in the secondary coil is small compared to the number of turns in the primary coil.

[T continues to write notes from his daftari, all but 2 students are writing]

T: it is wound on the magnetic material. [He talks about what lamination means and holds up pieces of a dismantled core of a transformer. He does not explain why it is laminated.]

---

<sup>86</sup> misconception over the reason for step up transformers in the national grid



### PRINCIPLE OF WORKING OF A TRANSFORMER

The primary voltage is applied on the input the primary circuit of the primary circuit as this is wound on the magnetic material it sets up a changing magnetic flux which induces the secondary emf in the secondary circuit

let  $E_p$  = primary emf  
 $E_s$  = secondary emf  
 $N_p$  = no. of turns in 1<sup>st</sup> coil  
 $N_s$  = no. turns in 2<sup>nd</sup> coil

The primary emf is proportional to the no. of turns in primary windings. The secondary induced emf is also proportional to the number of turns in the secondary coil.

$$E_p \propto N_p$$
$$E_s \propto N_s$$

T: there fore we can see that: [writes]

$$E_p/E_s = N_p/N_s$$

#### Example

A transformer with primary and secondary windings of 100 and 50 turns respectively is connected to 100V main supply. What will be the output if it is 100% efficient?

Soln

Data analysis

No turns in primary  $N_p=100$   
No turns in secondary  $N_s= 50$   
Efficiency = 100%  
Emf of primary,  $E_p = 100V$   
Emf of secondary,  $E_s = ?$

T: from our formula here:

Writes :

$$E_p/E_s = N_p/ N_s$$

How can you get  $E_s$ ?

[repeats question 4 times then writes]

$$E_s = E_p N_s / N_p$$
$$= 100 \times 50 / 100$$
$$= 50 \text{ V}$$

T: what type of transformer is this one? [nominates student]

B: step down

T: why?

B: the input is bigger than the output

#### SYMBOLS OF TRANSFORMER

1. the transformer that is not having the core [draws symbol]
2. the transformer having the magnetic core material [draws symbol]

[holds up the transformer]

T: this one is having the core. A transformer is designed so that very little energy is lost for its efficiency to be high [writes this sentence on the board]

T: [talks about soft iron core] What is a soft iron?

B: A soft iron is a material whereby it can become magnetised very easily

T Writes:

#### Important features:

- a) low resistance copper wires (coils) used so that the internal energy lost is small.  $\text{Energy} = I^2 R$
- b) laminated core to reduce eddy currents
- c) the core are made of soft magnetic material
- d) efficient core design: primary flux links to secondary flux

T: the laminations must be well binded.

[stresses the term 'well binded' many times. Shows the separate plates and points out that there is some oil but gives no explanation for why it is there]

T: If its not well binded you can hear the sound of the transformer in the radio speakers<sup>87</sup> MISCO

T: Efficiency [writes:]

---

<sup>87</sup> misconception- failed attempt at bridging

Efficiency of a transformer  
Just like other machines the transformer obeys the law of conservation of energy that is:  
Work input = work output  
i.e. power input = power output

Power = IV

$$E_p I_p = E_s I_s$$

$$E_p = E_s I_s / I_p$$

$$\frac{E_p}{E_s} = \frac{I_s}{I_p} = \frac{N_p}{N_s}$$

This means that if the transformer steps up the emf 1000 times, the current is stepped down 1/1000 times.

[gets class to repeat the formula orally chorusing]

T: we have to discuss the factors that cause the efficiency of the machine to be not 100%  
What are the factors causing the efficiency to be less than 100%?

[silence]

T: I told you last time that before the teacher should come you should read on your own.  
Anyone?

S: loss in the coil

T: others?

S: loss due to eddy currents in the core

T: writes then reads out:

#### FACTORS REDUCING THE EFFICIENCY OF A TRANSFORMER

- 2) copper losses: these are caused by the loss of power due to resistance of the wire in the coil.
- 2) Iron losses: these are caused by the eddy currents that are generated in the core and generate heat. They also act like breaks as they oppose the causative current

3) Hysteresis losses These are caused by work done by the input power to magnetise the core of the transformer

4) Poor magnetic flux linkage between the primary and secondary coils causing a flux leakage

T: let me take a question.

[C: silence]

T: this is a big area covered in a short time therefore go and read on your own.  
[lesson ends]

## **Post lesson Interview**

R= Ruth (interviewer)

T= Teacher (interviewee)

### **Biography**

A levels at High school X 2001-2002

few months working at a tea plantation

2002-2004 Zebaki TTC, Physics and Chemistry

### **Review of the lesson**

R: when you were preparing this, how did you go about preparing the lesson?

T: preparing the lesson? First of all I considered the time of the period, the time of the period was 80 minutes that's 2 periods, now that was the thing to consider before you can prepare

Again we were to look on the difficulty of the content

The nature of the class again. That was one of the factors because you cannot prepare a large content to be taught if the class is having slow learners, therefore these are the considerations I thought before I made preparation for a subject.

R: so what were the activities you planned during the lesson?

T: that the teacher should do?

R: yes

T: because of time you know we are behind on the syllabus, therefore what we do now it is to provide some concepts to students. What we made is distributing books to students so that when you highlight them they could go and read it in their own time and they will never \_\_\_\_ [inaudible] if that is they can come and ask the teacher. But activities to be done in the class by that time it was,... they were not very much considered. Instead some of them could have been done in practicals. You know physics is having paper 1 and paper 2?

R: yes

T: now the rest of them are going to be done in the practical papers, yes. We're going to teach them practicals.

R: so when you say practicals, here do they do the alternative to practical or the...

T: it is alternative but for the time being if we are having the materials. You know we are having this so called what....ahh...what do they call it is....we use the available materials to make some simple experiment that could be done for example, the sonometer in waves. Some of the experiments, for example, for the induction coil can be made in our school and others....because the school is not having apparatus therefore you do very few and students are doing alternative to practical papers, yes.

R: so do they have practical lessons at this school?

T: In the school?

R: yes, you said some of the activities...

T: yes. Practical lessons are not made at this time, practical lessons are made after finishing the theories we will go...we finish the theory papers first and we shall be coming to the practical papers whereby we could meet electricity, ah waves, magnetism and whatever . Now these are to be done after completing the theory..., what? Topics.

R: so, will you finish all of the topics and then teach the practical?

T: yes, for example now, whenever I finish this one it is magnetic effects of an electric current, whenever I finish this one now I, I'll be finishing with the last topic optical instruments, you see. Now there I could mark the end of all the topics, and then I start, what? I start the practicals before they enter the exams. Although the topics are so low. Optical instruments, do you know optical instruments?

R: yes

T: you know them?

R: the telescope

T: the telescope, we do consider the eye also, yes.

R: so why do you teach it that way, why do you do all the theory and then the practical?

T: what?

R: why do you teach it that way, why do you do all the theory and then the practical?

T: Ah, you know these two papers, these two national examinations, the first paper, that is paper 1, very much is based on theories, principles, laws and whatever, its applications. While the paper 2 very much is based on derivations and sometimes based on, things that are....experiments that are, based very much on experiments, yes experiments. For example heat and what, even though it could come in alternative to practical paper, but questions are experimentally oriented, yes, experimentally oriented. That's why we do teach both because if you teach only one paper it means that the average, when comes the time for average in the national exams, your students could fail even though they have passed in the first paper. Hmmm, that why we do it this way.

R: so why do you teach it in that order, you teach the theory and then the practical?



T: what?

R: so why do you teach it in that order, you teach the theory and then the practical?

T: ahhh, we think of getting ready, you know when you teach it, even if you ask Mr Msusa he can, he has not taught in practicals because, of what, even those volumetric analyses or whatever, they are going to repeat.

R: OK

T: yeah, they are... it is just an issue of memory if you, you,...teach it very early it means students could forget and then you come to repeat again therefore wastage of time. Therefore you wait until they're very near to their examinations and then you teach that one. That's why we wait, yes.

R: And, when you were preparing, maybe writing your notes, and preparing the lesson, were you using,,, what information were you using? What information from your head, maybe from your past experience?

T: Some of the information was my past experience, from my colleague, some of the knowledge I received from different books and very few, very few things I have taken from the book you brought here, In a minute, here [shows page from text book I had given the school] I took some points and use it to teach

R: which other books did you use?

T: Principles of Physics

R: that's Nelkon isn't it?

T: Nelkon, yes...Abbott, and this one I don't know what ...this one it is: O level physics, it is by Njao these are the materials I used.

R: do you have the ...physics for secondary schools books 1,2,3,...

T: we do have but very few.

R: right, do you use that one?

T: The material that is found is very little, there primarily I received diagrams and whatever because they are in simple ways, you see. The diagrams in Abbott and whatever, they are complicated. Students could not understand. But what is talked in the TIE, those books of institute of education, is very much summarised, very much summarised. Therefore you cannot get a concept, you see that there must be an aid of these other titles.

R: when you started your lesson the first thing you gave them was a definition of a transformer, and in fact one of the boys gave a definition. I think that was the first question, "what is a transformer" and therefore he gave you a definition. Why do you think its... why did you start with a definition?

T: first of all I didn't start with a definition. What I did is recalling the past subject. I wanted them to tell me what is an eddy current and whatever, whatever. There intentionally it was to bring back the minds of the students to the class, to remind them that now it is time. You see, and I thought it is good when I started transformers to ask the students that: "what is a transformer?" so that, its not good always that the teacher, yourself, you give out the definition, it could be spoon-feeding. Now what we do is to make students try themselves to define, to define as to what they know. If there are corrections then you make, so you can give yours. Because it's a habit of students to speculate here and there to see what is there? What is there? Therefore we can think a student went somewhere and saw a word therefore she or he tried to look up its meaning or whatever. Therefore you ask them, or you could give some, some words relating to a transformer and whatever. You show them. They give the function and whatever, and then you ask them 'now, can you define the device?' you see, that's a good way.

R: but is it important for them to have a definition of a transformer at an early stage?

T: early stage? What do you mean?

R: it was, you know, one of the first things you gave when you were on this topic, to give a concise definition of a transformer.

T: constructing the definition of the transformer,,, I thought it is important because, going on while others they don't know what it is you are dealing about I think is not good, therefore I thought it is good that everyone has got the concept "what is it", then the nature of it. And that is why I moved with it in the class, yes, that's why when I asked them "what is the function of this? Where is it put?" they said 'radio', what, what therefore seems they know the device therefore you see. And when you move with it in the class students...and they are very much happy to see.

R: I was quite impressed when you held up the one from the radio, they all knew that it was from a radio and they also knew that it was a step down transformer. How do you think they knew that? What do you think they knew?

T: they knew that one because, you know a transformer present in a radio, of course it is to minimise voltage and when I asked them that what is the function of this in the radio they know that 240 V from the supply mains should be reduced, that why I asked them that 4 dry cells have how many volts they replied therefore they know themselves that 240 should be reduced to 6V therefore it must be stepdown and not step up, and probably if it is step up it means that you burn your, what? Your appliance. That's why they discovered the transformer.

R: So had you told this, had you asked this class to prepare themselves for this lesson, you said, I think during the lesson about...

T: what?

R: had you asked the class to read, had you said “tomorrow or next week we will be doing transformers, you should read about transformers”. How come they...when you were asking questions you know, the students were able to say what is a transformer, they were able to say what is step down, what is step up, how did they know that?

T: you know, whenever you leave in a class usually we tell students of what should be following, yes, what should be following. And already I announce to them before you came, that after transformer we shall be running to a certain topic. What I do on my own, I distributed books and whenever I moved in that area in the class I tell them that something will be following therefore before I reach in that area students should have been moved in that area before me. To read the area, you see. Therefore if you go to teach you find the students are participating because they have passed through before, yes.

R: and when you...how will you assess this work?

T: evaluation you mean?

R: yes

T: how do you evaluate whether the subject is successive or not?

R : yes

T: evaluation it is in that area it is on how students attempt to various oral questions, yes, various oral questions and how do they participate in solving questions, you see. That's where you can see that now the question is, the subject has achieved its goals you see. And what we were taught from the college is that: make sure you participate the students. Then when students participate then it's where evaluation is very simple. Especially oral questions, and if time allows, as you saw me doing in form III, you allow the students to come to the board, yes and do on their own. Yes you see to act as a teacher, therefore it is something good.

R: so the evaluation of that lesson it was going on while you were asking the questions?

T: while the subject was going on, also I was evaluating by asking questions, you see, by asking questions although, next time I could repeat again, next time, next period I could not start a new subject without passing with that one. It is a bit, it is a bit [inaudible] you look on the what you were teaching last time and then you continue with the other, yes, or providing questions and the you mark because I'm having oral questions then I can provide questions in written form so that they attempt and then I'll be marking, to see whether everyone has got what I intended.

R: So the written exercises would be in order to assess, to evaluate their understanding?

T: it is evaluation because exercises is one of the instruments used to evaluate, what? Educational achievement. You see, now an exercise, tests or whatever possible can show me that this topic was well understood for example for today what we were doing in a class, in form IIIA, I understood that some of the things were not clearly covered. It is something of that.

R: now if you were teaching this lesson, may be at a school which had a laboratory and everything in it how would you teach the lesson differently?

T: Of course the lesson was to be more interesting and was to be understood more because, for example, there was only one while in other places there are many transformers in such a way that every student could be looking at it you see and, if possible we would dismantle one so that we see what? The coils inside. Now there it was not possible because the only one is there and if you dismantle that one it means that now you cannot use it again because it can be misplaced, or whatever, and it is distraction. You are worried of what could I do before this one, you see. Really if there are some materials present the subject can be more successive than you do.

What I thought helped me in the class was that the students have ever seen, what? The transformer, that device in a radio. Probably they didn't know the function of it but they have ever seen is it? Yes.

R: where did you get your transformers from?

T: it was somewhere but some of them was,... one was destructed, that one I borrowed somewhere in order for students to look it is...(laughs) it is... that's why I was afraid to dismantle it.

[After tape is switched off I ask the teacher whether he has any questions for me.]





## Appendix 4: Preliminary Findings as Presented to Teachers/Tutors at Feedback Workshops

### Sources of knowledge:

- Teachers get their knowledge from:
  - text books
  - reference books
  - syllabus
  - teacher training course
  - workshops
  - experience
  - their own education
- Teachers frequently comment that the teacher should not be the only source of knowledge in the classroom but that the student is an important source.
- Students get their knowledge from:
  - notes borrowed from other students (most used source)
  - text books
  - reference books
  - primary schooling

### Organisation of Knowledge

**Definitions** are very important.

e.g. it is important for a student to know the definition of a living organism before going on with the topic

It is important for students to know a definition of 'physics' at the start of the physics course

**Categories:** knowledge is organised into categories

i.e. into subjects, topics and subtopics and sometimes within subtopics e.g. types of chemical reaction

Categories tend to be **formal** and **discrete**

## **Presentation of Knowledge: the science lesson**

- Most lessons start with an oral recap of the previous lesson. This is so that the teacher can lead the students from what is known to what is unknown.
- Whole class discussion, led by the teacher is the most used format.
- Discussion in groups/ pairs is also popular, especially with students.
- Teachers generally use English except for discipline and classroom management. Many students say that they prefer the teacher to mix Kiswahili and English, especially for introducing difficult scientific terms.
- Notes: while teaching, teachers often just give a summary on the board. Students then write more extensive notes- either from the teacher or finding them themselves from other sources.
- Practicals: these are often left to be taught at the end of form IV as preparation for the practical examination.

## **Assessment**

- Teachers often say that they want to see if students have 'caught the concept' - as if the concept is like a ball that the teacher throws to the students for them to catch.
- Oral assessment (oral questions at the end of the period) is a preferred method for assessing whether students have understood a lesson.
- Written homework exercises are not frequently given. Teachers see written homework as problematic as a form of assessment as students often copy from each other.
- End of topic and end of term tests are also used for assessment.

The main purpose of all these activities is for the teacher to know how much the students have understood.

# Appendix 5: Assessment form for trainees on teaching practice

MINISTRY OF EDUCATION CULTURE  
CONFIDENTIAL [REDACTED] TEACHERS COLLEGE

## TEACHING PRACTICE ASSESSEMENT FORMS

Name of Student ..... College class/group .....  
Combination ..... School .....  
District ..... Region .....  
Subject ..... Time .....  
School/Class ..... Date .....

SN	ITEM	AM%	MA	COMMENTS
1.	Lesson Plan	5		
2.	(a) Skills	4		
	(b) Subject knowledge	4		
3.	Teaching methods	4		
4.	Teaching AIDS	10		
5.	Manner and Voice	5		
6.	Board and Handwriting	4		
7.	Class activities	3		
8.	Class Control	3		
9.	Personality	2		
10.	Candidate's self assessment of the Lesson	6		
	TOTAL MARKS	50		

### GENERAL COMMENTS

.....  
.....

A      B      C      D      E  
50-45   44-35   34-25   24-15   14-01

- The original with no marks on shall be given to the students.  
The copy with marks shall be retained by tutor for presenting to the Academic Dean's Office.

Total marks ..... Name of Tutor/Examiner .....  
Grade ..... Signature .....

CONFIDENTIAL



## **Appendix 6: Common Science Texts in Tanzanian Schools**

Abbott, A. F. (1989). Physics (Fifth Edition). London, Heinemann Educational.

Atkinson, A. (1983). Certificate Chemistry (4th edition), Harlow, Longman.

Beckett, B. S. (1986). Biology: A Modern Introduction: GCSE Edition. Oxford, Oxford University Press.

Holderness, A. and J. Lambert (1987). A New Certificate Chemistry, London, Heinemann Educational Secondary Division.

Nelkon, M. (1990). Principles of Physics. Harlow, Longman.

Tanzania Institute of Education (1995). Biology for Secondary Schools book 1 & 2. Dar es Salaam, Tanzania Institute of Education.

Tanzania Institute of Education (1995). Physics for Secondary Schools books 1-4. Dar es Salaam, Tanzania Institute of Education.

Tanzania Institute of Education (1995). Secondary School Chemistry books 1 & 2. Dar es Salaam, Tanzania Institute of Education.